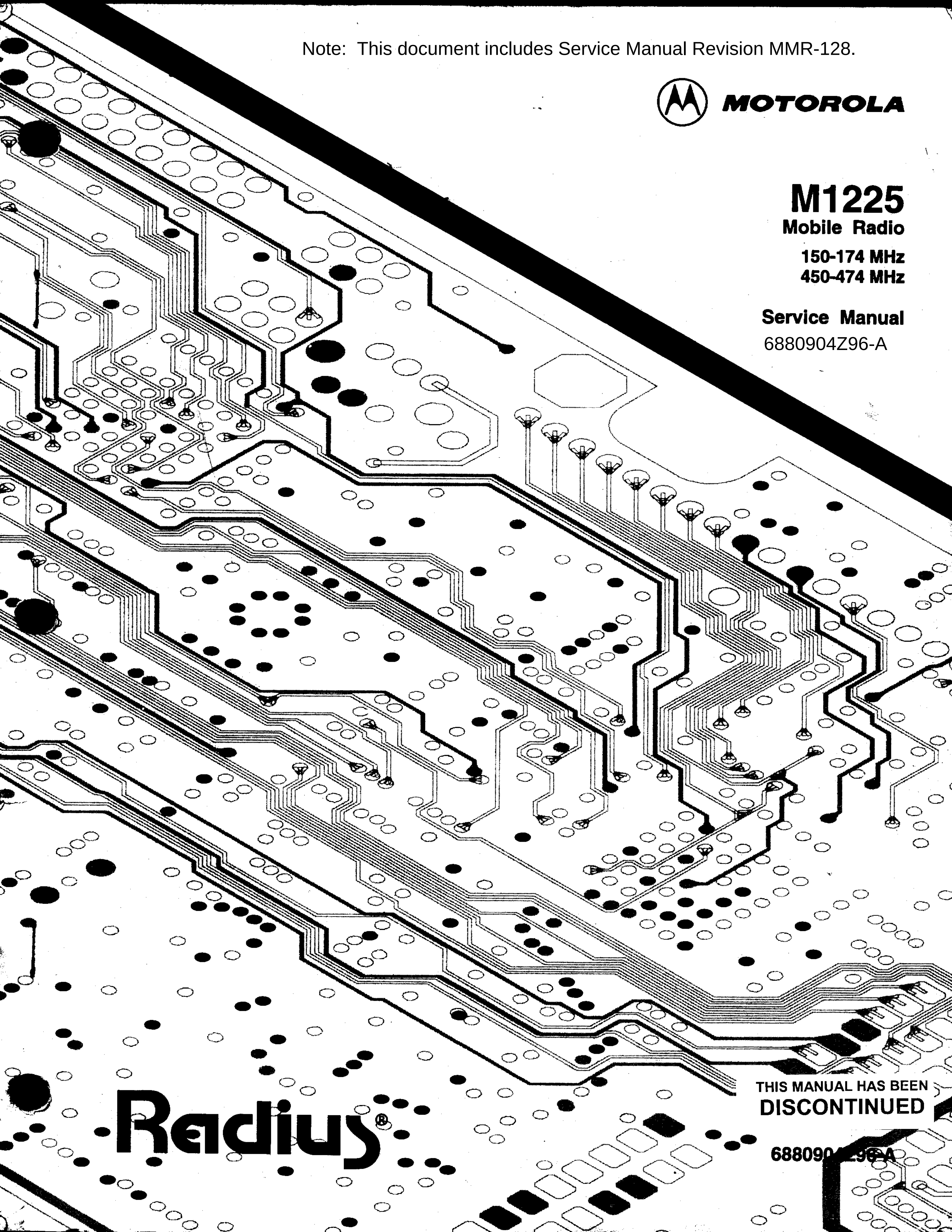
Note: This document includes Service Manual Revision MMR-128.

MOTOROLA



M1225

Mobile Radio

150-174 MHz
450-474 MHz

Service Manual

6880904Z96-A

Radius®

THIS MANUAL HAS BEEN
DISCONTINUED

6880904Z96-A

Radius®

service manual revision

GENERAL:

This revision outlines changes that have occurred since the printing of your service manual. Use this information to correct your manual.

INSTRUCTION MANUAL AFFECTED:

6880904Z96-A M1225 Mobile Radio Service Manual

REVISION DETAILS:

1. This supplement contains the new VHF, 10-25 W, 150-170 MHz radio models with new model charts, and revised specifications and theory of operation pages. In addition, the circuit board details, schematic diagrams and parts list have also been supplied. Please refer to the attached pages.

ATTACHMENTS

Model Charts

M1225
20-Channel
VHF Mobile Radio
150 - 170 MHz
10-25 Watts RF Power

MODEL	FREQ.	DESCRIPTION
M33DGC90J2AA	20	12.5/25 kHz, 10-25 W

ITEM	DESCRIPTION
HLN9644_	Display Board (20-Freq.)
HLN9268_	Hardware Kit
(See Note)	Main Board, 12.5/25 kHz, 10-25 W

M33DGC90J2AA	Item	Description	HLN9644_	HLN9268_	(See Note)
X	HUD3231_	Radio, 12.5/ 25 kHz, 10-25 W	X	X	X
X	HMN3008_	Microphone			
X	HLN9154_	Non-Locking Bracket			
X	HKN4137_	Power Cable			
X	HLN9155	M1225 20-Channel Manual Kit			

Note: Main board kits are not available separately for field replacement

MODEL	FREQ.	DESCRIPTION
M33DGC90E2AA	4	12.5/25 kHz, 10-25 W

M1225
4-Channel
VHF Mobile Radio
150 - 170 MHz
10-25 Watts RF Power

ITEM	DESCRIPTION
HLN9887_	Display Board (4-Freq.)
HLN9268_	Hardware Kit
(See Note)	Main Board, 12.5/25 kHz, 10-25 W

M33DGC90E2AA	Item	Description	HLN9887_	HLN9268_	(See Note)
X	HUD3253_	Radio, 12.5/25 kHz, 10-25 W	X	X	X
X	HMN3008_	Microphone			
X	HLN9154_	Non-Locking Bracket			
X	HKN4137_	Power Cable			
X	HLN9893	M1225 4-Channel Manual Kit			

Note: Main board kits are not available separately for field replacement

Specifications

GENERAL

	VHF		UHF	
Model Series:	M33DGC	M43DGC	M44DGC, M34DGC	
Frequency Range:	150-170 MHz	150-174 MHz	450-474 MHz	
RF Output:	10-25 W	25-40 W	10-25 & 25-40 W	
Channel Spacing:	12.5 kHz & 20/25/30 kHz		12.5 kHz	20/25 kHz
Dimensions:	H 1.73" X W 6.61" X D 4.25" (H 44mm X W 168mm X D 108mm)			
Weight:	36 oz. (1.02kg)			
Channel Capacity:	20 or 4 Channels			
Freq. Separation:	24 MHz			
Input Voltage:	13.6 ±10%			
Current Drain: Standby Receive @Rated Audio	 300 mA 1.5 A			
Transmit	7 A @ 25 W, 12.5 A @ 40 W		12.5 A @ 40 W	
Squelch Capabilities:	Tone Coded, Digital Coded and/or Carrier Squelch			

TRANSMITTER

	VHF	UHF
Freq. Stability (-30C to +60C):	±0.00025%	
Spurs/Harmonics:	-23 dBm (5 µW)	
Audio Response:*	+1/-3 dB, relative to 6 dB/octave pre-emphasis, 300-3000 Hz (2550 Hz @ 12.5 kHz)	
FCC Designation:	ABZ99FT3038, ABZ99FT3037	ABZ99FT4044, ABZ99FT3038
FCC Modulation: 20/25/30 kHz 12.5 kHz	 16K0F3E 11K0F3E	 16K0F3E 11K0F3E
Output Impedance:	50 ohms	
Modulation Sensitivity:	80 mV rms for 60% deviation @ 1000 Hz	
FM Noise: 20/25/30 kHz 12.5 kHz	 45 dB 40 dB	 40 dB 35 dB
Audio Distortion:	<3% EIA (@1000 Hz, 60% of Rated Max. Deviation)	

RECEIVER

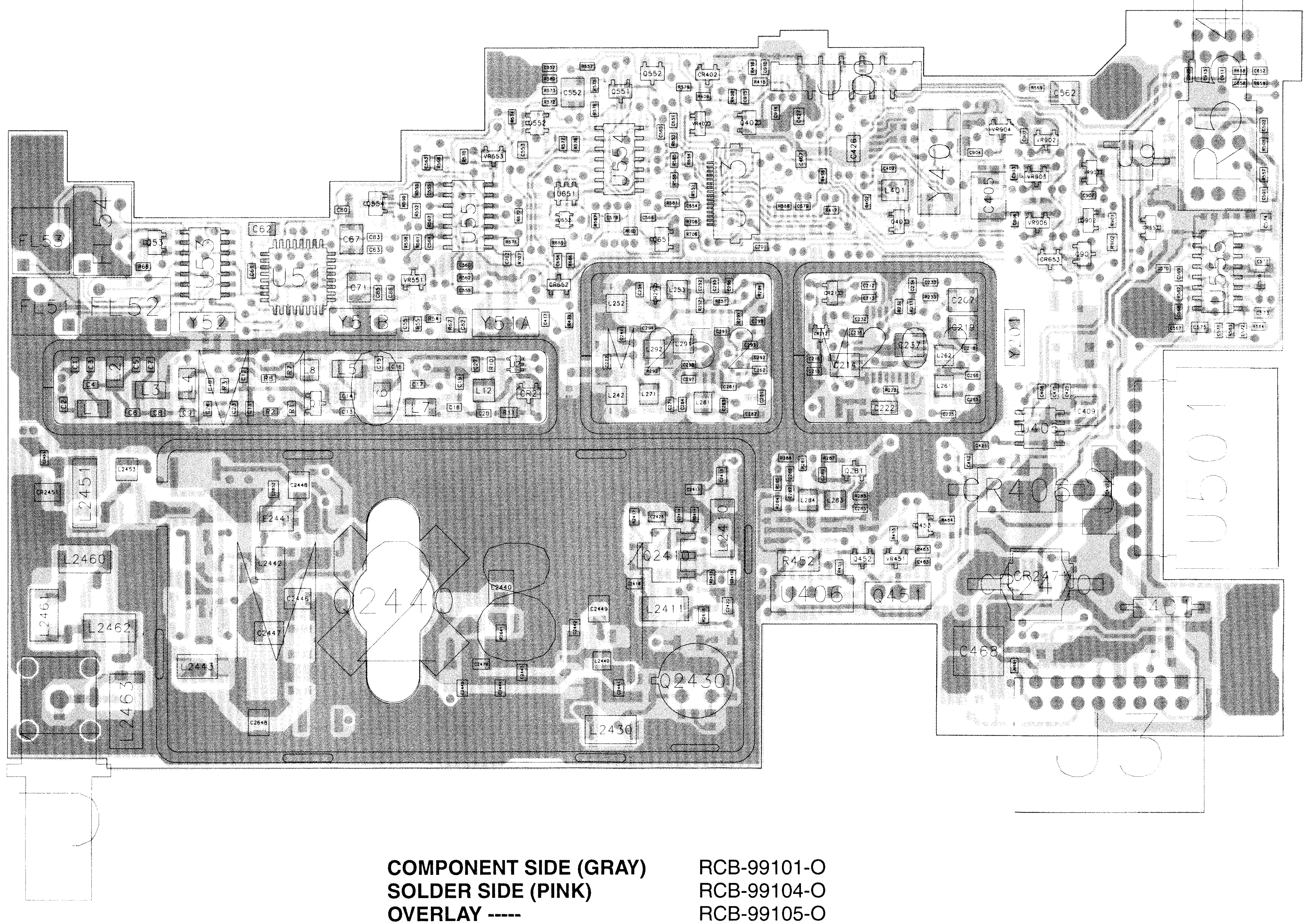
	VHF		UHF	
	12.5 kHz	**25 kHz**	**12.5 kHz**	**25 kHz**
Freq. Stability (-30C to +60C):	±0.00025%			
Sensitivity TIA @ 12 dB SINAD:	0.35 µV	0.30 µV	0.35 µV	0.30 µV
Squelch (internally pre-set):	10 dB SINAD			
Selectivity TIA:	65 dB	75 dB	60 dB	70 dB
Intermodulation TIA*:	65 dB	75 dB	60 dB	70 dB
Spurious Rejection:	75 dB		70 dB	
Image / Half IF Rejection:	70 dB		70 dB	
Audio Output: 8 ohms (external) 16 ohms (internal)	 7.5 W @ 5% distortion 4.0 W Nominal			
Input impedance:	50 ohms			
TIA Usable Bandwidth:	1.2 kHz	2 kHz	1.2 kHz	2 kHz

* Local mode adds 10 dB protection against wideband interference.

MILITARY STANDARDS 810 C, D & E FOR MOUNTING ACCESSORIES

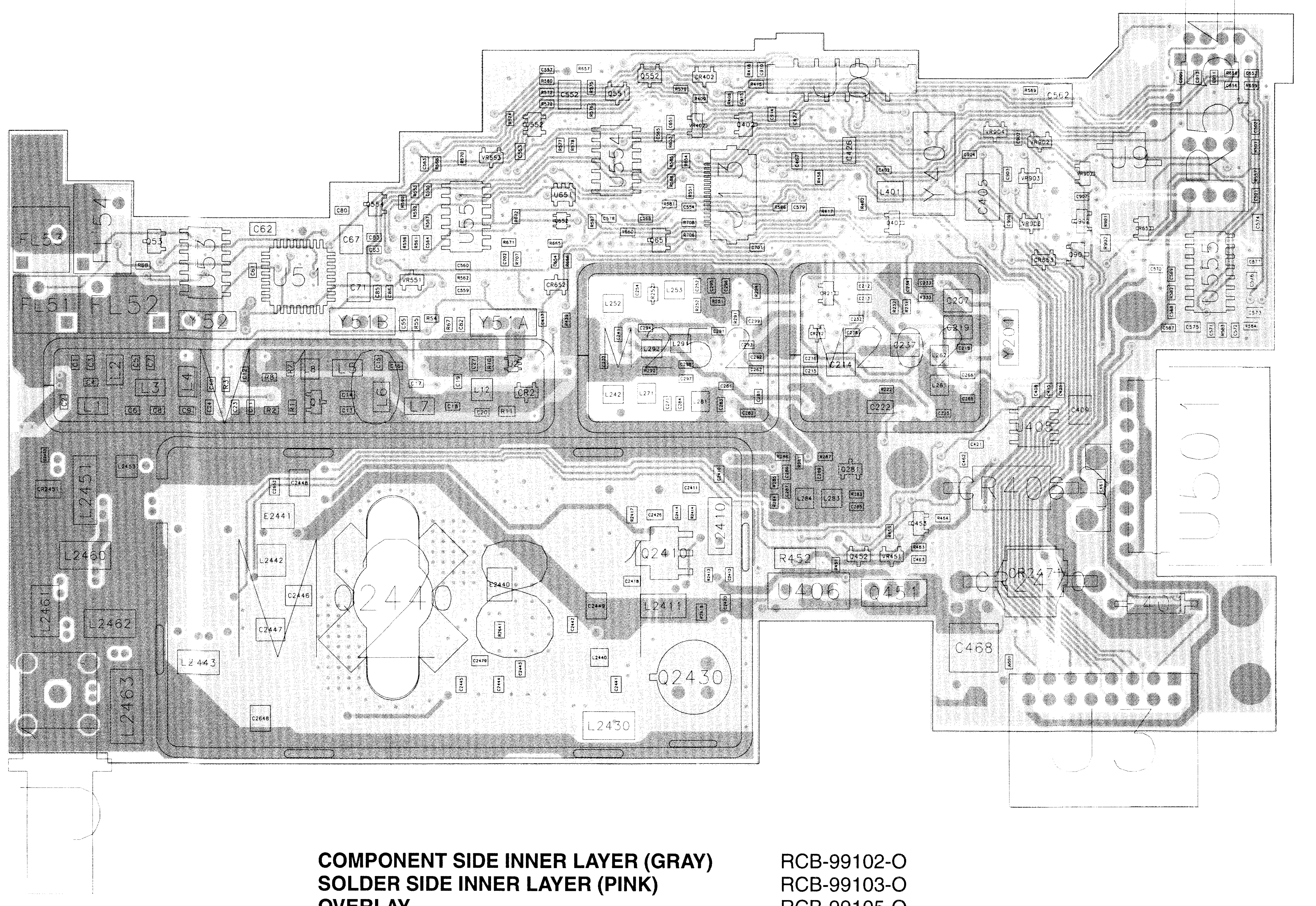
Applicable MIL-STD	Required Mounting Accessory	810C		810D		810E	
		Method	Procedures	Method	Procedures	Method	Procedures
Vibration:	Standard Non-Locking Bracket	514.2	8	514.3	1	514.4	1
Shock:	Standard Non-Locking Bracket	516.2	1, 3	516.3	1	516.4	1
Crash Hazard	Any M1225 Mounting Accessory	516.2	3	516.3	5	516.4	5

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE



COMPONENT SIDE (GRAY) RCB-99101-O
SOLDER SIDE (PINK) RCB-99104-O
OVERLAY ----- RCB-99105-O

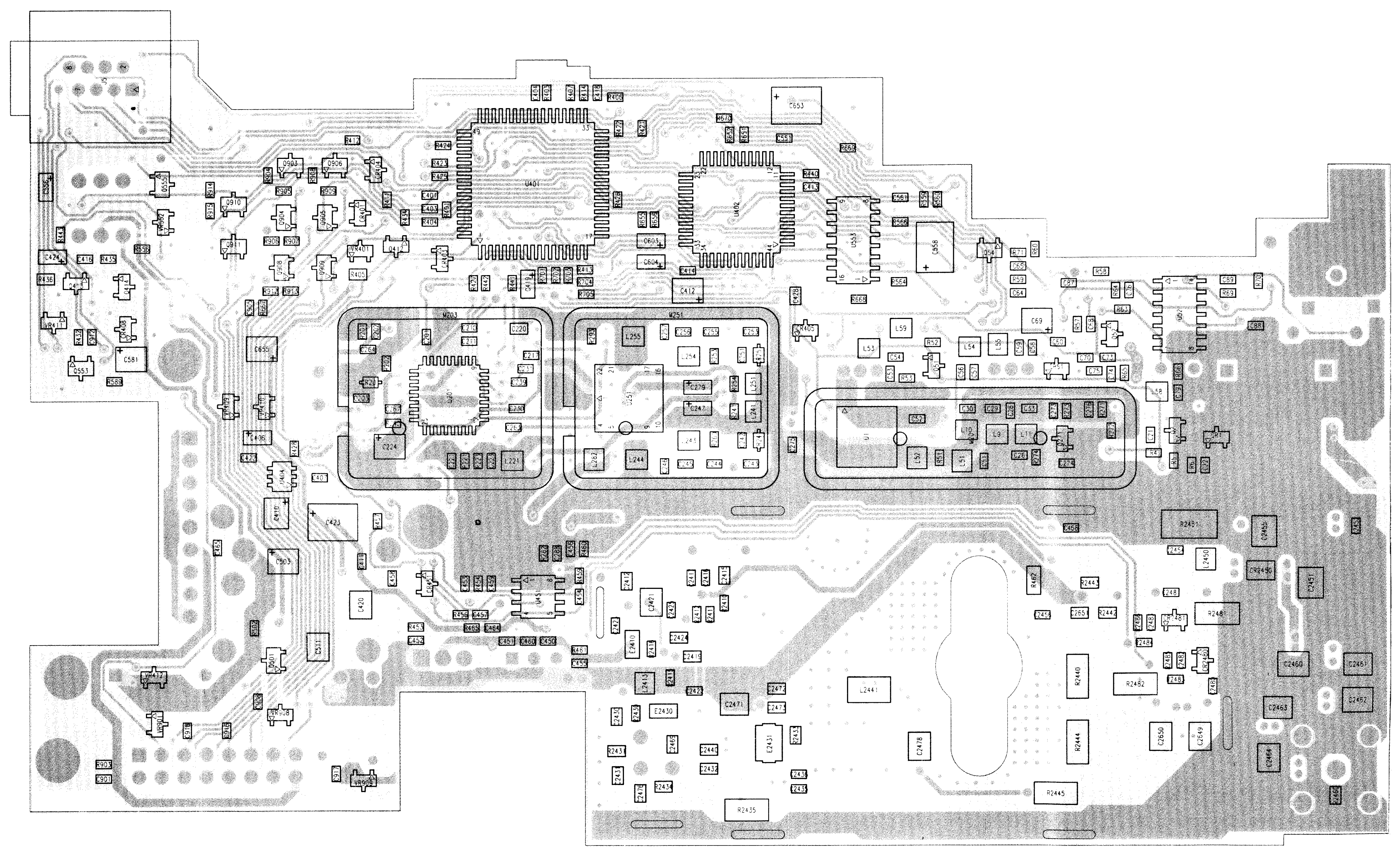
COMPONENT SIDE VIEW



COMPONENT SIDE INNER LAYER (GRAY) RCB-99102-O
SOLDER SIDE INNER LAYER (PINK) RCB-99103-O
OVERLAY ----- RCB-99105-O

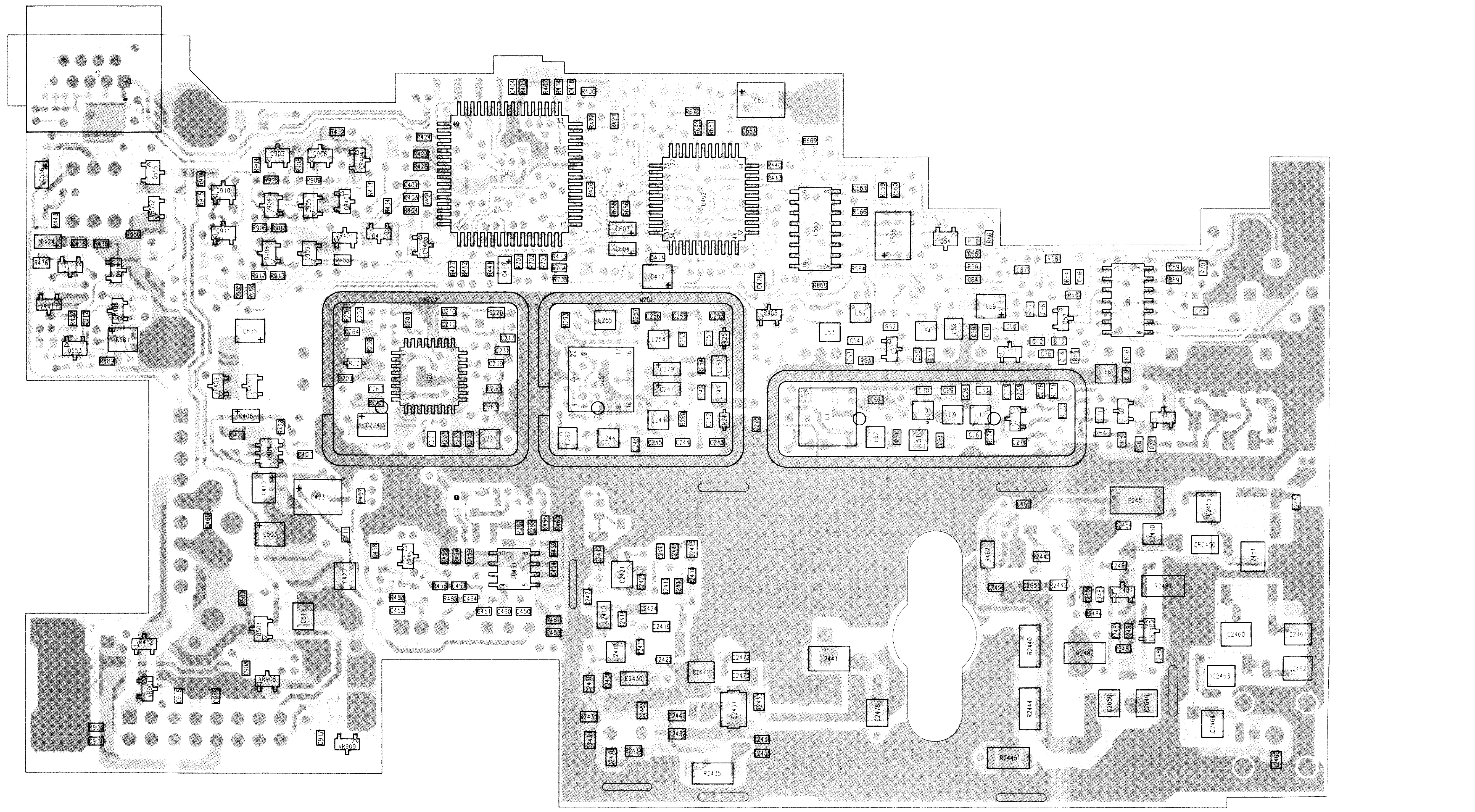
COMPONENT SIDE VIEW

Circuit Board Details for
VHF Main Boards, 150-170 MHz, 12.5 & 25 kHz, 10-25 W
(Part of HUD3231A & HUD3253A Radios)



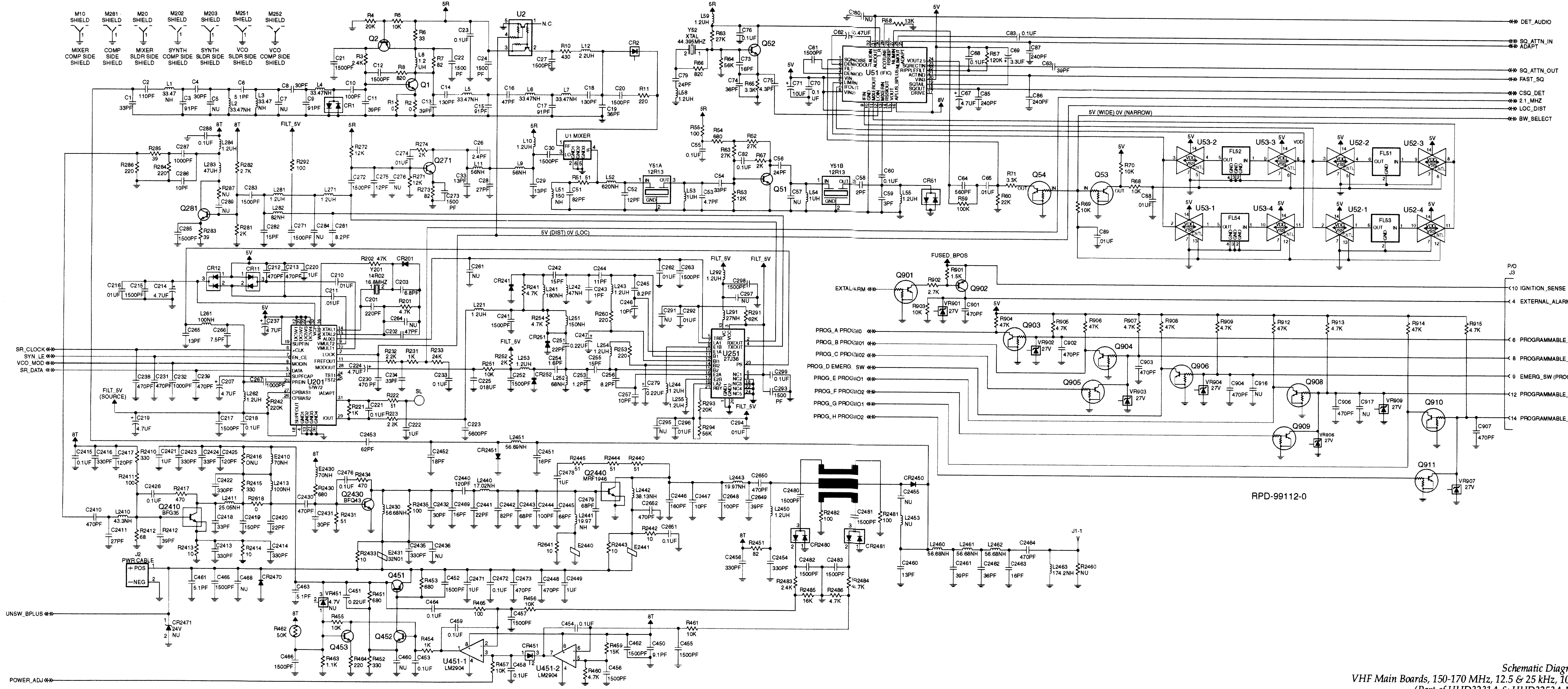
COMPONENT SIDE INNER LAYER (GRAY)	RCB-99102-O (REV)
SOLDER SIDE INNER LAYER (PINK)	RCB-99103-O (REV)
OVERLAY -----	RCB-99106-O

SOLDER SIDE VIEW



COMPONENT SIDE (GRAY)	RCB-99101-O (REV)
SOLDER SIDE (PINK)	RCB-99104-O (REV)
OVERLAY -----	RCB-99106-O

SOLDER SIDE VIEW



Schematic Diagram for
VHF Main Boards, 150-170 MHz, 12.5 & 25 kHz, 10-25 W
(Part of HUD3231A & HUD3253A Radios)
(Sheet 1 of 2)

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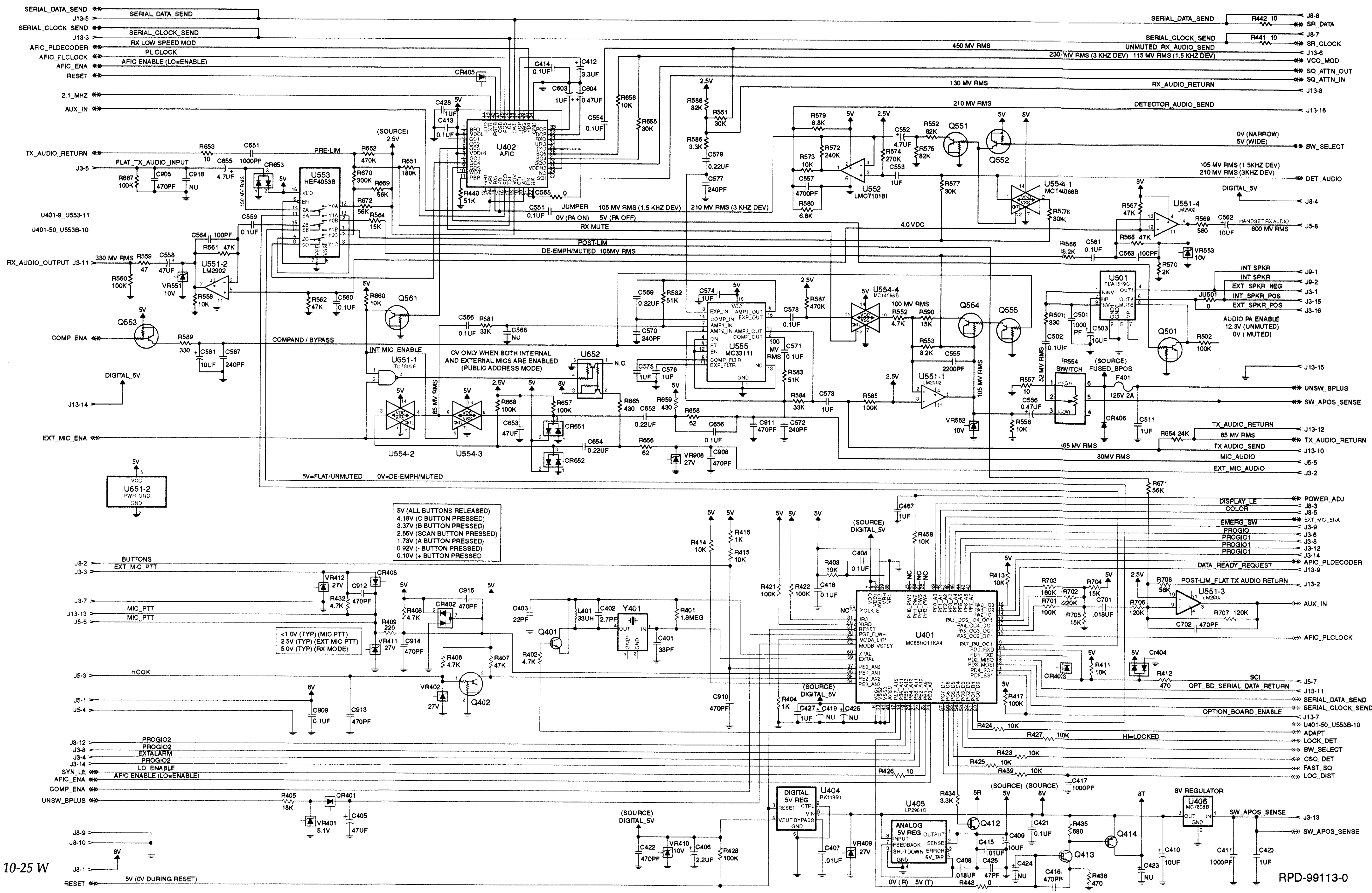

Schematic Diagram for
VHF Main Boards, 150-170 MHz, 12.5 & 25 kHz, 10-25 W
(Part of HUD3231A & HUD3253A Radios)
(Sheet 2 of 2)

RPD-99113-0

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Parts List

HUD3253A & HUD3231A VHF Radio, 12.5/25 kHz,
150-170 MHz, 10-25 W PL-991007-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF +/-5%; 50 V: unless otherwise stated
C1	21-13740F39	33 pF
C2	21-13740F52	110 pF
C3	21-13740F50	91 pF
C4	21-13740F38	30 pF
C5	---	Not Used
C6	21-13740F20	5.1 ±0.25 pF
C7	---	Not Used
C8	21-13740F38	30 pF
C9	21-13740F50	91 pF
C10	21-13740F51	100 pF
C11	21-13740F41	39 pF
C12	21-13741F29	1500 pF
C13	21-13740F41	39 pF
C14	21-13740F54	130 pF
C15	21-13740F50	91 pF
C16	21-13740F43	47 pF
C17	21-13740F50	91 pF
C18	21-13740F54	130 pF
C19	21-13740F40	36 pF
C20	21-13741F29	1500 pF
C21, 22	21-13741F29	1500 pF
C23	21-13743E20	0.1 uF, ±10%; 16 V
C24	21-13741F29	1500 pF
C26	21-13740F12	2.4 ±0.25 pF
C27	21-13741F29	1500 pF
C28	21-13740F37	27 pF
C29	21-13740F30	13 pF
C30	21-13741F29	1500 pF
C33	21-13740F30	13 pF
C51	21-13740F49	82 pF
C52	21-13740F29	12 pF
C53	21-13740F19	4.7 ±0.25 pF
C54	21-13740F39	33 pF
C55	21-13743E20	0.1 uF, ±10%; 16V
C56	21-13740F36	24 pF
C57	---	Not Used
C58	21-13740F10	2 ±0.25 pF
C59	21-13740F14	3 ±0.25 pF
C60	21-13743E20	0.1 uF, ±10%; 16 V
C61	21-13741F29	1500 pF
C62	23-11049A05	tantalum 0.47 uF, ±10%; 25 V
C63	21-13740F41	39 pF
C64	21-13740F69	560 pF
C65	21-13741F49	.01 uF
C67	23-11049J11	tantalum 4.7 uF, ±10%; ±16 V
C68	21-13743E20	0.1 uF, ±10%; 16 V
C69	23-11049J07	tantalum 3.3 uF, ±10%; 20 V
C70	21-13743E20	0.1 uF, ±10%; 16 V
C71	23-11049A57	tantalum 10 uF, ±10%; 16 V
C73	21-13740F32	16 pF
C74	21-13740F40	36 pF
C75	21-13740F18	4.3 ±0.25 pF
C76	21-13743E20	0.1 uF, ±10%; 16 V
C79	21-13740F36	24 pF
C80	---	Not Used
C82, 83	21-13743E20	0.1 uF, ±10%; 16 V
C85 thru 87	21-13740F60	240 pF
C88, 89	21-13741F49	.01 uF
C201	21-13740F59	220 pF
C202	21-13740L34	47 pF, 2%
C203	21-13740L14	6.8 ±0.1 pF
C207	23-11049J11	tantalum 4.7 uF, ±10%; 16 V
C210, 211	21-13741F49	.01 uF
C212, 213	21-13741F17	470 pF
C214	23-11049J11	tantalum 4.7 uF, ±10%; 16 V
C215	21-13741F29	1500 pF
C216	21-13741F49	.01 uF
C217	21-13741F29	1500 pF
C218	21-13743E20	0.1 uF, ±10%; 16 V
C219	23-11049J11	tantalum 4.7 uF, ±10%; 16 V
C220	21-13928E01	1 uF, ±10%; 10 V
C221	21-13743E20	0.1 uF, 10%; 16 V
C222	23-11049A07	tantalum 1 uF, ±10%; 16 V
C223	21-13741F43	5600 pF
C224	23-11049J11	tantalum 4.7 uF, ±10%; 16 V
C225	21-13743E05	.018 uF, ±10%; 16 V
C230, 231	21-13741F17	470 pF
C232	21-13741F25	1000 pF
C233	21-13743E20	0.1 uF, 1±0%; 16 V
C234	21-13740F39	33 pF
C237	23-11049J11	tantalum 4.7 uF, ±10%; 16 V

HUD3253A & HUD3231A VHF Radio, 12.5/25 kHz,
150-170 MHz, 10-25 W PL-991007-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C238	21-13741F17	470 pF
C239	21-13741F17	470 pF
C241	21-13741F29	1500 pF
C242	21-13740L22	15 pF, 2%
C243	21-13740F03	1 ±0.25 pF
C244	21-13740L19	11 pF, 2%
C245	21-13740L16	8.2, ±0.1 pF
C246	21-13740L18	10 pF, 2%
C247	23-11049A03	tantalum 0.22 uF, ±10%; 35 V
C251	21-13740L26	22 pF, 2%
C252	21-13741F29	1500 pF
C253	21-13740F04	1.1 ±0.25 pF
C254	21-13740F10	2 ±0.25 pF
C255	21-13740L22	15 pF, 2%
C256	21-13740L16	8.2 ±0.1 pF
C257	21-13740L18	10 pF, 2%
C261	---	Not Used
C262	21-13741F49	.01 uF
C263	21-13741F29	1500 pF
C264	---	Not Used
C265	21-13740F30	13 pF
C266	21-13740F24	7.5 ±0.25 pF
C267	21-13741F25	1000 pF
C271 thru 273	21-13741F29	1500 pF
C274	21-13741F49	.01 uF
C275	21-13740F29	12 pF
C276	---	Not Used
C279	23-11049A03	tantalum 0.22 uF, ±10%; 35 V
C281	21-13740F25	8.2 ±0.25 pF
C282	21-13740F31	15 pF
C283	21-13741F29	1500 pF
C284	---	Not Used
C285	21-13741F29	1500 pF
C286	21-13740F27	10 pF
C287	21-13741F25	1000 pF
C288	21-13743E20	0.1 uF, ±10%; 16 V
C289	---	Not Used
C291	---	Not Used
C292	21-13743E20	0.1 uF, ±10%; 16 V
C293	21-13741F29	1500 pF
C294	21-13741F49	.01 uF
C295	---	Not Used
C296	21-13743E20	0.1 uF, ±10%; 16 V
C297	---	Not Used
C298	21-13741F29	1500 pF
C299	21-13743E20	0.1 uF, ±10%; 16 V
C401	21-13740F39	33 pF
C402	21-13740F13	2.7 ±0.25 pF
C403	21-13740F35	22 pF
C404	21-13743E20	0.1 uF, ±10%; 16 V
C405	23-11049J43	tantalum 47 uF, ±10%; 10 V
C406	23-11049A40	tantalum 2.2 uF, ±10%; 10 V
C407	21-13741F49	.01 uF
C408	21-13743E05	.018 uF, ±10%; 16 V
C409, 410	23-11049A57	tantalum 10 uF, ±10%; 16 V
C411	21-13741F25	1000 pF
C412	23-11049J07	tantalum 3.3 uF, ±10%; 20 V
C413, 414	21-13743E20	0.1 uF, ±10%; 16 V
C415	21-13741F49	.01 uF
C416	21-13741F17	470 pF
C417	21-13741F25	1000 pF
C418	21-13743E20	0.1 uF, ±10%; 16 V
C419	---	Not Used
C420	21-13741W01	1 uF, ±10%; 25 V
C421	21-13743E20	0.1 uF, ±10%; 16 V
C422	21-13741F17	470 pF
C423, 424	---	Not Used
C425	21-13740F43	47 pF
C426	---	Not Used
C427, 428	21-13928E01	1 uF, ±10%; 10 V
C450	21-13740F26	9.1 ±0.25 pF
C451	21-13743K16	0.22 uF, +80/-20%; 16 V
C452	21-13741F29	1500 pF
C453, 454	21-13743E20	0.1 uF, ±10%; 16 V
C455 thru 457	21-13741F29	1500 pF
C458, 459	21-13743E20	0.1 uF, ±10%; 16 V
C460	---	Not Used
C461	21-13740F20	5.1 ±0.25 pF
C462	21-13741F29	1500 pF
C463, 464	21-13740F20	5.1 ±0.25 pF
C465, 466	21-13741F29	1500 pF
C467	21-13928E01	1 uF, ±10%; 10 V
C468	---	Not Used

HUD3253A & HUD3231A VHF Radio, 12.5/25 kHz,
150-170 MHz, 10-25 W PL-991007-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C501	21-13741F25	1000 pF
C502	21-13743E20	0.1 uF, ±10%; 16 V
C503	23-11049A57	tantalum 10 uF, ±10%; 16 V
C511	21-13741W01	1 uF, ±10%; 25 V
C551	21-13743E20	0.1 uF, ±10%; 16 V
C552	23-11049J11	tantalum 4.7 uF, ±10%; 16 V
C553	21-13928E01	1 uF, ±10%; 10 V
C554	21-13743E20	0.1 uF, ±10%; 16 V
C555	21-13741F33	2200 pF
C556	23-11049A05	tantalum 0.47 uF, ±10%; 25 V
C557	21-13741F41	4700 pF
C558	23-11049J43	tantalum 47 uF, ±10%; 10 V
C559 thru 561	21-13743E20	0.1 uF, ±10%; 16 V
C562	23-11049A57	tantalum 10 uF, ±10%; 16 V
C563, 546	21-13740F51	100 pF
C565	06-62057B47	jumper
C566	21-13743E20	0.1 uF, ±10%; 16 V
C567	21-13740F60	240 pF
C568	---	Not Used
C569	21-13743K16	0.22 uF, +80/-20%; 16 V
C570	21-13740F60	240 pF
C571	21-13743E20	0.1 uF, ±10%; 16 V
C572	21-13740F60	240 pF
C573 thru 576	21-13928E01	1 uF, ±10%; 10 V
C577	21-13740F60	240 pF
C578	21-13743E20	0.1 uF, ±10%; 16 V
C579	21-13743K16	0.22 uF, +80/-20%; 16 V
C581	23-11049A57	tantalum 10 uF, ±10%; 16 V
C603	23-11049A07	tantalum 1 uF, ±10%; 16 V
C604	23-11049A05	tantalum 0.47 uF, ±10%; 25 V
C651	21-13741F25	1000 pF
C652	21-13743K16	0.22 uF, +80/-20%; 16 V
C653	23-11049J43	tantalum 47 uF, ±10%; 10 V
C654	21-13743K16	0.22 uF, +80/-20%; 16 V
C655	23-11049J11	tantalum 4.7 uF, ±10%; 16 V
C656	21-13743E20	0.1 uF, ±10%; 16 V
C701	21-13743E05	.018 uF, ±10%; 16 V
C702	21-13741F17	470 pF
C901 thru 908	21-13741F17	470 pF
C909	21-13743E20	0.1 uF, ±10%; 16 V
C910 thru 915	21-13741F17	470 pF
C916 thru 918	---	Not Used
C2410	21-13740A71	470 pF
C2411	21-13740A39	27 pF
C2412	21-13740A43	39 pF
C2413, 2414	21-13741F13	330 pF
C2415	21-13743A19	0.1 uF, ±10%; 16 V
C2416	21-13741F13	330 pF
C2417	21-13740F53	120 pF
C2418	21-13740A41	33 pF
C2419	21-13740A59	150 pF
C2420	21-13740A37	22 pF
C2421	21-13741W01	1 uF, ±10%; 16 V
C2422, 2423	21-13741F13	330 pF
C2424	21-13740A41	33 pF
C2425	21-13740F53	120 pF
C2426	21-13743A19	0.1 uF, ±10%; 16 V
C2430	21-13740A71	470 pF
C2431, 2432	21-13740A40	30 pF
C2435	21-13741F13	330 pF
C2436	---	Not Used
C2440	21-13740A57	120 pF
C2441	21-13740A37	22 pF
C2442	21-13740A53	82 pF
C2443	21-13740A51	68 pF
C2444	21-13740A55	100 pF
C2445	21-13740A51	68 pF
C2446	21-11078B48	160 pF; 100 V
C2447	21-80060M19	10 pF; 500 V
C2448	21-11078B59	470 pF
C2449	21-13741W01	1 uF, ±10%; 25 V
C2451	21-80060M24	16 pF; 500 V
C2452	21-13740F33	18 pF
C2453	21-13740F46	62 pF
C2454	21-13741F13	330 pF
C2455	---	Not Used
C2456	21-13741F13	330 pF
C2460	21-80060M22	13 pF; 500 V
C2461	21-11078B32	39 pF; 100 V
C2462	21-80060M32	36 pF; 500 V
C2463	21-11078B19	16 pF; 100 V
C2464	21-11078B59	470 pF; 100 V
C2471	21-13741W01	1 uF, ±10%; 25 V

HUD3253A & HUD3231A VHF Radio, 12.5/25 kHz,
150-170 MHz, 10-25 W PL-991007-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C2472	21-13743A19	0.1 uF, ±10%; 16 V
C2473	21-13740A71	470 pF
C2474	---	Not Used
C2476	21-13743A19	0.1 uF, ±10%; 16 V
C2478	21-13741W01	1 uF, ±10%; 25 V
C2479	21-13740A51	68 pF
C2480 thru 2483	21-13741F29	1500 pF
C2648	21-11078B42	100 pF; 100 V
C2649	21-11078B32	39 pF; 100 V
C2650	21-11078B59	470 pF; 100 V
C2651	21-13743A19	0.1 uF, ±10%; 16 V
C2652	21-13740A71	470 uF
		diode: (see note)
CR1	48-80154K03	dual Schottky SOT
CR2	48-80142L01	silicon PIN SOT MMBV3401
CR51	48-80154K03	dual Schottky SOT
CR201	48-02245J22	silicon varactor SOT 1T363
CR211	48-13833C07	dual silicon SOT MMBD7000
CR212	48-05218N57	dual silicon SOT
CR241	48-62824C03	silicon varactor SOT 1SV232
CR251, 252	48-62824C03	silicon varactor SOT 1SV232
CR401	48-05129M76	silicon SOT
CR402	48-13833C07	dual silicon SOT MMBD7000
CR403	48-80939T01	Schottky SOT
CR404	48-13833C07	dual silicon SOT MMBD7000
CR405	48-05129M76	silicon SOT
CR406	48-83553T02	4A 200 PIV MUR420
CR408	48-05129M76	silicon SOT
CR451	48-05129M76	silicon SOT
CR651 thru 653	48-13833C07	dual silicon SOT MMBD7000
CR2450, 2451	48-02482J02	silicon PIN MA4P1250
CR2470	48-80236E07	transient suppressor
CR2480, 2481	48-82290T02	dual Schottky SOT HSMS-2802
		ferrite beads:
E2410	24-80067M01	ferrite bead
E2430	24-80067M01	ferrite bead
E2431	24-80132N01	ferrite bead
E2440, 2441	24-84657R01	ferrite bead
		fuse:
F401	65-05214E01	2 amp axial lead
		filter:
FL51	91-80098D14	455 kHz 4F
FL52	91-80097D14	455 kHz 6F
FL53	91-80098D16	455 kHz 4D
FL54	91-80097D16	455 kHz 6D
		connector, receptacle:
J1	09-80476U01	mini UHF coax
J2	30-04510J01	power cable assembly (includes J2)
J3	28-04503J01	16-pin, accessories
J5	09-04426J01	telephone type, 8 contact, microphone
J8	09-04422J01	10 pin, display board
J9	28-04423J01	2-pin, internal speaker
J13	09-80472U01	16-pin, option board
		jumper:
JU501	06-62057B47	jumper
		coil, rf:
L1 thru 7	24-60591G24	9 turns
L8	24-62587X69	chip 1.2 uH; 5%
L9	24-62587X50	chip 56 nH; 5%
L10	24-62587X69	chip 1.2 uH; 5%
L11	24-62587X50	chip 56 nH; 5%
L12	24-62587N72	chip 2.2 uH; 5%
L51	24-62587X55	chip 0.15 uH; 5%
L52	24-62587X63	chip 0.62 uH; 5%
L53, 54	24-62587X68	chip 1 uH; 5%
L55	24-62587X69	chip 1.2 uH; 5%
L58, 59	24-62587X69	chip 1.2 uH; 5%
L221	24-62587X69	chip 1.2 uH; 5%
L241	24-62587V37	chip 0.18 uH; 5%
L242	24-62587X49	chip 47 nH; 5%
L243, 244	24-62587X69	chip 1.2 uH; 5%
L251	24-62587V36	chip 0.15 uH; 5%
L252	24-62587X51	chip 68 nH; 5%
L253 thru 255	24-62587X69	chip 1.2 uH; 5%
L261	24-62587X53	chip 0.1 uH; 5%
L262	24-62587X69	chip 1.2 uH; 5%

HUD3253A & HUD3231A VHF Radio, 12.5/25 kHz,
150-170 MHz, 10-25 W PL-991007-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L271	24-62587X69	chip 1.2 uH; 5%
L281	24-62587X69	chip 1.2 uH; 5%
L282	24-62587X52	chip 82 nH; 5%
L283	24-62587X49	chip 47 nH; 5%
L284	24-62587X69	chip 1.2 uH; 5%
L291	24-62587X46	chip 27 nH; 5%
L292	24-62587X69	chip 1.2 uH; 5%
L401	24-60578C43	chip 33 uH
L2410	24-60591G77	9 turns
L2411	24-69591E69	7 turns
L2413	24-62587X53	chip 0.1 uH
L2430	24-60591R29	8 turns
L2440	24-60591C40	5 turns
L2441	24-60591D69	6 turns
L2442	24-60591M77	4 turns
L2443	24-60591D69	6 turns
L2450	24-62587X69	chip 1.2 uH
L2451	24-60591J77	56.69 nH
L2453	---	Not Used
L2460 thru 2462	24-60591R29	8 turns
L2463	24-60591V77	12 turns
		transistor: (see note)
Q1	48-13827A07	NPN; type MMBR941
Q2	48-13824A17	PNP; type MMBT3906
Q51, 52	48-13827A07	NPN; type MMBR941
Q53, 54	48-80947V01	digital NPN; type DTC144W
Q271	48-13827A07	NPN; type MMBR941
Q281	48-13827A07	NPN; type MMBR941
Q401	48-80214G02	NPN; type MMBT3904
Q402	48-80947V01	digital NPN; type DTC144W
Q412	48-13824A17	PNP; type MMBT3906
Q413	48-80214G02	NPN; type MMBT3904
Q414	48-80141L03	PNP; type BCW68G
Q451	48-02245J25	PNP; type 2SB1142S
Q452, 453	48-80214G02	NPN; type MMBT3904
Q501	48-80947V01	digital NPN; type DTC144W
Q551	48-80947V01	digital NPN; type DTC144W
Q552 thru 554	48-80494U01	digital PNP; type DTA144W
Q555	48-80947V01	digital NPN; type DTC144W
Q651	48-80947V01	digital NPN; type DTC144W
Q901	48-80947V01	digital NPN; type DTC144W
Q902	48-80141L03	PNP; type BCW68G
Q903 thru 906	48-80947V01	digital NPN; type DTC144W
Q908 thru 911	48-80947V01	digital NPN; type DTC144W
Q2410	48-02245J24	NPN; type BFG35
Q2430	48-02245J28	NPN; type BFQ43S
Q2440	48-80225C22	NPN; type M25C22
		resistor, fixed: +/-5%; 1/16 W: unless otherwise stated
R1, 2	06-62057B47	0
R3	06-62057A58	2.4k
R4	06-62057A80	20k
R5	06-62057A73	10k
R6	06-62057A13	33
R7	06-62057A23	82
R8	06-62057A47	820
R10	06-62057A40	430
R11	06-62057C59	220; 1/10 watt
R51	06-62057A18	51
R52	06-62057A83	27k
R53	06-62057A75	12k
R54	06-62057A45	680
R55	06-62057A25	100
R57	06-62057A99	120k
R58	06-62057A76	13k
R59	06-62057A97	100k
R60	06-62057A81	22k
R63	06-62057A83	27k
R64	06-62057A91	56k
R65	06-62057A61	3.3k
R66	06-62057A47	820
R67	06-62057A56	2k
R68 thru 70	06-62057A73	10k
R71	06-62057A61	3.3k
R201	06-62057A57	2.2k
R202	06-62057A89	47k
R221	06-62057A49	1k
R222	06-62057A18	51
R223	06-62057A57	2.2k
R231	06-62057A49	1k
R232	06-62057A57	2.2k

HUD3253A & HUD3231A VHF Radio, 12.5/25 kHz,
150-170 MHz, 10-25 W PL-991007-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R233	06-62057A82	24k
R241	06-62057A65	4.7k
R242	06-62057B06	220k
R251	06-62057A73	10k
R252	06-62057A55	1.8k
R253	06-62057A33	220
R254	06-62057A65	4.7k
R260	06-62057A33	220
R271, 272	06-62057A75	12k
R273	06-62057A23	82
R274	06-62057A56	2k
R281	06-62057A56	2k
R282	06-62057A59	2.7k
R283	06-62057A15	39
R284	06-62057A33	220
R285	06-62057A15	39
R286	06-62057A33	220
R287	---	Not Used
R291	06-62057A92	62k
R292	06-62057A25	100
R293	06-62057A80	20k
R294	06-62057A91	56k
R401	06-62057B28	1.8 meg
R402	06-62057A65	4.7k
R403	06-62057A73	10k
R404	06-62057A49	1k
R405	06-62057C81	1.8k; 1/10 watt
R406	06-62057A65	4.7k
R407	06-62057A89	47k
R408	06-62057A65	4.7k
R409	06-62057A33	220
R411	06-62057A73	10k
R412	06-62057A41	470
R413 thru 415	06-62057A73	10k
R416	06-62057A49	1k
R417	06-62057A97	100k
R421, 422	06-62057A97	100k
R423 thru 425	06-62057A73	10k
R426	06-62057A01	10
R427	06-62057A73	10k
R428	06-62057A97	100k
R432	06-62057A65	4.7k
R434	06-62057A61	3.3k
R435	06-62057A45	680
R436	06-62057C67	470; 1/10 watt
R439	06-62057A73	10k
R440	06-62057A90	51k
R441, 442	06-62057A01	10
R443	06-62057B47	0
R451	06-62057A45	680
R452	06-80195M37	330; 1/2 watt
R453	06-62057A45	680
R454	06-62057A49	1k
R455 thru 458	06-62057A73	10k
R459	06-62057A77	15k
R460	06-62057A65	4.7k
R461	06-62057A73	10k
R462	06-05621T02	thermistor 50k @ 25 degrees C
R463	06-62057A50	1.1k
R464	06-62057A33	220
R465	06-62057A25	100
R501	06-62057A37	330
R502	06-62057A97	100k
R551	06-62057A84	30k
R552	06-62057A65	4.7k
R553	06-62057A71	8.2k
R554	18-04405J02	variable 2k with switch
R556	06-62057A73	10k
R557	06-62057A01	10
R558	06-62057A73	10k
R559	06-62057A17	47
R560	06-62057A97	100k
R561, 562	06-62057A89	47k
R564	06-62057A77	15k
R566	06-62057A71	8.2k
R567, 568	06-62057A89	47k
R569	06-62057A43	560
R570	06-62057A56	2k
R572	06-62057B07	240k
R573	06-62057A73	10k
R574	06-62057B08	270k
R575	06-62057A95	82k
R576	06-62057A92	62k

HUD3253A & HUD3231A VHF Radio, 12.5/25 kHz,
150-170 MHz, 10-25 W PL-991007-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R577, 578	06-62057A84	30k
R579, 580	06-62057A69	6.8k
R581	06-62057A85	33k
R582, 583	06-62057A90	51k
R584	06-62057A85	33k
R585	06-62057A97	100k
R586	06-62057A61	3.3k
R587	06-62057B14	470k
R588	06-62057A95	82k
R589	06-62057A37	330
R590	06-62057A77	15k
R651	06-62057B04	180k
R652	06-62057B14	470k
R653	06-62057A01	10
R654	06-62057A82	24k
R655	06-62057A84	30k
R656	06-62057A73	10k
R657	06-62057A97	100k
R658	06-62057A20	62
R659	06-62057A40	430
R660	06-62057A73	10k
R665	06-62057A40	430
R666	06-62057A20	62
R667, 668	06-62057A97	100k
R669	06-62057A91	56k
R670	06-62057B09	300k
R671, 672	06-62057A91	56k
R701	06-62057A97	100k
R702	06-62057B06	220k
R703	06-62057B03	160k
R704, 705	06-62057A77	15k
R706, 707	06-62057A99	120k
R708	06-62057A91	56k
R901	06-62057A53	1.5k
R902	06-62057C85	2.7k; 1/10 watt
R903	06-62057A73	10k
R904	06-62057A89	47k
R905	06-62057A65	4.7k
R906	06-62057A89	47k
R907	06-62057A65	4.7k
R908	06-62057A89	47k
R909	06-62057A65	4.7k
R912	06-62057A89	47k
R913	06-62057A65	4.7k
R914	06-62057A89	47k
R915	06-62057A65	4.7k
R2410	06-62057A37	330
R2411	06-62057A25	100
R2412	06-62057A21	68
R2413	06-62057A01	10
R2414	06-62057A01	10
R2415	06-62057A37	330; 1/10 watt
R2416	---	Not Used
R2417	06-62057C67	470; 1/10 watt
R2430	06-62057A45	680
R2431	06-62057C44	51; 1/10 watt
R2433	06-62057C27	10; 1/10 watt
R2434	06-62057C67	470; 1/10 watt
R2435	06-80195M25	100; 1/2 watt
R2440	06-80195M18	51; 1/2 watt
R2441 thru 2443	06-62057C27	10; 1/10 watt
R2444, 2445	06-80195M18	51; 1/2 watt
R2451	06-80194M23	82; 1 watt
R2481, 2482	06-80195M25	100; 1/2 watt
R2483	06-62057A58	2.4k
R2484	06-62057A65	4.7k
R2485	06-62057A78	16k
R2486	06-62057A65	4.7k
R2618	06-62057C01	0 ohm; 1/10 watt
R2641	06-62057C27	10; 1/10 watt
		integrated circuit: (see note)
U1	51-80505D05	double-balanced mixer
U2	48-09939C04	dual transistor switch UMC3TL
U51	51-80605E02	receiver system
U52, 53	51-05663U35	quad analog switch 4066B
U201*		synthesizer
U251	51-05414S84	VCO/buffer
U401*		microcomputer MC68HC11KA4
U402	51-80604E01	audio filter
U404	51-80633C01	5 V regulator TK11950
U405	51-05469E65	5 V regulator LP2951C
U406	51-13816D03	8 V regulator MC7808BT

HUD3253A & HUD3231A VHF Radio, 12.5/25 kHz,
150-170 MHz, 10-25 W PL-991007-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
U451	51-80932W01	dual op-amp LM2904 SOIC
U501	51-80147R01	audio power amp TDA1519C
U551	51-02198J28	quad op-amp LM2902D SOIC
U552	51-62852A09	single opamp LMC7101
U553	51-84704M60	triple 2-channel switch 4053B
U554	51-05663U35	quad analog switch 4066B
U555	51-13811A35	compander MC33111
U651	51-05461G61	NAND gate TC7S00F
U652	48-09939C04	dual transistor switch UMC3TL
		voltage regulator: (see note)
VR401	48-80140L06	zener diode 5.1 V SOT
VR402	48-80948V01	zener diode 27 V SOT
VR409	48-80948V01	zener diode 27 V SOT
VR410	48-80140L15	zener diode 10 V SOT
VR411 412	48-80948V01	zener diode 27 V SOT
VR451	---	Not Used
VR551 thru 553	48-80140L15	zener diode 10 V SOT
VR901 thru 904	48-80948V01	zener diode 27 V SOT
VR906 thru 909	48-80948V01	zener diode 27 V SOT
		crystal: (see note)
Y51	91-80112R13	filter 44.85 MHz (includes Y51A and Y51B)
Y52	48-80606B07	44.395 MHz
Y201*		16.8 MHz
Y401	48-80113R01	7.9488 MHz
	non-referenced items	
	14-05160A02	crystal insulator (for Y201)
	26-04398J01	VCO/synthesizer shield (4 used)
	26-04399J01	receiver mixer bottom shield
	26-04400J01	receiver front end top shield
	26-04419J01	PA shield frame
	26-04420J01	PA shield cover
	26-80481U01	Tx buffer top shield
	42-80281L01	ground clip (2 used for Q2640)

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

*Designators marked with an (*) denote parts which are not field serviceable. Recalibration of the radio using specialized factory equipment is mandatory when these components are replaced in order to guarantee the specified frequency stability of the radio at temperature extremes.

MMR-128

Parts List for
VHF Main Boards, 150-170 MHz, 12.5 & 25 kHz, 10-25 W
(Part of HUD3231A & HUD3253A Radios)

Section 2
Theory of Operation

Overview

This section provides detailed theory of operation for the components of the M1225 mobile radio.

Receiver Circuitry

VHF Receiver Front End

The received signal applied to the radio's antenna input connector is routed through the harmonic filter and PIN diode antenna switch. In the receive mode, PIN diodes CR2450 and CR2451 are both off, allowing the signal to pass unattenuated to the receiver front end filter. The insertion loss of the harmonic filter/ antenna switch is less than 1 dB. The harmonic filter provides 19 dB attenuation for image protection at 240 MHz, with increased attenuation at higher frequencies.

The signal is routed to a fixed-tuned 4 pole capacitive-coupled resonator filter having a 3 dB bandwidth of 50 MHz and a 1 dB bandwidth of 45 MHz centered at 162 MHz. Insertion loss is 1.7 dB. Attenuation for image protection is 42 dB at 240 MHz, with increasing attenuation at higher frequencies.

The output of the filter is matched to the base of RF amplifier Q1, which provides 19 dB of gain and has a noise figure of 3 dB. Current source Q2 is used to maintain the collector current of Q1 constant at 30 mA. Transistors Q1 and Q2 are supplied from the 5R source. This source is switched by transistor Q412 which is controlled by U401-54. 5R is only present in the receive mode. This reduces dissipation in Q1 during transmit. Diode CR1 clamps excessive input signals, protecting Q1.

The output of Q1 is applied to a fixed-tuned 3-pole series- coupled resonator filter having a 3 dB bandwidth of 60 MHz and a 1 dB bandwidth of 45 MHz centered at 162 MHz. Insertion loss is 1.3 dB. Attenuation for image protection is 35 dB at 240 MHz, with increasing attenuation at higher frequencies.

A pin diode attenuator is located between the 3-pole filter and the first mixer. The bias current through this diode is switched by dual-composite transistor switch U2. In the Distance mode, U2 is turned on by a logic high at U2-4 from U401-57. CR2 is forward-biased which bypasses R11, and no loss is introduced. In the Local mode, U2 and CR2 are off (U401-57 is low), inserting 10 dB of attenuation due to R11. Because the attenuator is located after the RF amplifier, receiver sensitivity is reduced only by 5 dB, while the overall third order input intercept is raised by 15 dB. Thus, the Local mode significantly reduces the susceptibility to IM-related interference.

The first mixer, U1, is a passive, double-balanced type. This mixer provides all of the necessary rejection of the half-IF spurious response, since the improvement due to filter selectivity is negligible at 150 MHz. High-side injection at +6 dBm is delivered to the first mixer from the injection buffer, Q271, in the VCO/buffer circuit.

The mixer output is connected to a diplexer network which matches its output to the first two pole crystal filter, Y51A, at the IF frequency of 44.85 MHz, and terminates it in a 51 ohm resistor, R51, at all other frequencies.

UHF Receiver Front End

The received signal applied to the radio's antenna input connector is routed through the harmonic filter and PIN diode antenna switch. In the receive mode, PIN diodes CR2650 and CR2651 are both off, allowing the signal to pass unattenuated to the receiver front end filter. The insertion loss of the harmonic filter/ antenna switch is less than 1 dB.

The signal is routed to a fixed-tuned 3 pole shunt resonator filter having a 3 dB bandwidth of 65 MHz and a 1 dB bandwidth of 40 MHz centered at 462 MHz. Insertion loss is 2.0 dB. Attenuation for image protection is 33 dB at 385 MHz, with increasing attenuation at lower frequencies.

The output of the filter is matched to the base of RF amplifier Q1, which provides 17 dB of gain and has a noise figure of 3 dB. Current source Q2 is used to maintain the collector current of Q1 constant at 30 mA. Transistors Q1 and Q2 are supplied from the 5R source. This source is switched by transistor Q412 which is controlled by U401-54. 5R is only present in the receive mode. This reduces dissipation in Q1 during transmit. Diode CR1 clamps excessive input signals, protecting Q1.

The output of Q1 is applied to a fixed-tuned 4 pole shunt resonator filter having a 3 dB bandwidth of 58 MHz and a 1 dB bandwidth of 40 MHz centered at 462 MHz. Insertion loss is 2.8 dB. Attenuation for image protection is 43 dB at 385 MHz, with increasing attenuation at lower frequencies.

A pin diode attenuator is located between the 4 pole filter and the first mixer. The bias current through this diode is switched by dual-composite transistor switch U2. In the Distance mode, U2 is turned on by a logic high at U2-4 from U401-57. CR2 is forward- biased which bypasses R11, and no loss is introduced. In the Local mode, U2 and CR2 are off (U401-57 is low), inserting 10 dB of attenuation due to R11. Because the attenuator is located after the RF amplifier, receiver sensitivity is reduced only by 5 dB, while the overall third order input intercept is raised by 15 dB. Thus, the Local mode significantly reduces the susceptibility to IM-related interference.

The first mixer, U1, is a passive, double-balanced type. This mixer provides all of the necessary rejection of the half-IF spurious response, since the improvement due to filter selectivity is negligible at 474 MHz. Low-side injection at +6 dBm is delivered to the first mixer from the injection buffer, Q271, in the VCO/buffer circuit.

The mixer output is connected to a diplexer network which matches its output to the first two pole crystal filter, Y51A, at the IF frequency of 44.85 MHz, and terminates it in a 51 ohm resistor, R51, at all other frequencies.

Receiver Back End

Q51 amplifies the IF signal from Y51A by approximately 20 dB. The output of Q51 is matched to a second two pole crystal filter, Y51B. The overall 3 dB bandwidth of the crystal filters is 17 kHz. The signal from Y51B is applied to the input of the receiver system IC U51-13. Diode CR51 prevents overload of the second mixer in the receiver system IC.

Q52 is controlled by crystal Y52 which provides the low side injection second local oscillator signal applied to U51-12. The filtered and amplified 44.85 MHz first IF signal mixes with the second local oscillator signal at 44.395 MHz to produce a second IF signal at 455 kHz. The second IF signal is then filtered by switchable ceramic filter FL51 or FL53, amplified, then filtered by switchable ceramic filter FL52 or FL54 and applied to the audio detector. U401-53 controls the bandwidth select switch, Q53, to switch the narrower bandwidth ceramic filters FL51 and FL52 for 12.5 kHz channel spacing or the wider ceramic filters FL53 and FL54 for 20/25/30 kHz channel spacing.

The audio detector is a phase-locked loop type. The free-running oscillator frequency is determined by capacitor C61. Detected audio from U51-31 is routed via noise-peak limiting stage U552 to Rx IN and PL In ports on the audio filter IC (AFIC) U401 (pins 14 and 15 respectively), and also via CMOS switch U553B to op-amp U551B, where output is routed to the accessory connector J3-11 (see "Low-Level Rx Audio").

U51 also contains the carrier-squelch circuitry. When an on-channel signal is present, the amount of high-frequency audio noise, at the detector, is reduced. This change in noise level is sensed to indicate the presence of an on-channel signal. The bandwidth of the sampled noise is determined by C64, C65, R59, R60, and R71 switched by Q54. U401-53 controls Q54 for 12.5 kHz or 20/25/30 kHz channel spacing operation. Squelch sensitivity is adjusted electronically by an attenuator in U402. Squelch noise is routed from U51-26 to U402- 23, and the adjusted noise level is returned from U402-26 back to U51-23. This noise level is detected in U51 and compared to a preset threshold. Noise levels greater than a preset threshold, indicating weak or no signal present, cause U51-18 to go low. This is routed to microcomputer port PC5 (U401-55). When the noise level decreases below the threshold, due to on-channel quieting, U51-18 and therefore U401-55 go high. This indicates an on-channel signal is present, and the microcomputer unmutes the audio path.

Components R57, C68 and C69 determine squelch time constants as a function of the charging currents supplied by U51. These charging currents vary from weak to strong signal conditions, providing a variable squelch closing time-constant. For weak signals the time constant is long to minimize "chattering" or rapid muting and unmuting of the audio. For strong signals, where the carrier-absent to carrier-present conditions are substantial, the closing time-constant is shortened to minimize the length of the "squelch-tail".

Frequency Generation System

The frequency generation system utilizes two IC's, the Fractional-N Synthesizer (U201) and the VCO/Buffer (U251). Designed to maximize compatibility, the two IC's provide many functions which would normally require additional circuitry.

The frequency generation circuitry is supplied from the analog 5 V supply regulated by U405. The synthesizer IC further filters this voltage (SUPFOUT, U201-18, 4.65 Vdc) and supplies it to the VCO/Buffer IC.

The synthesizer also interfaces with the logic and AFIC circuitry. Synthesizer programming is accomplished through the SR DATA (U201-5), SR CLOCK (U201-6), and SYN LE (U201-7) lines by microcomputer U401. A serial stream of 98 bits is sent whenever the synthesizer is programmed. Synthesizer lock is indicated by a logic high at LOCK DET pin U201-2, and a logic low indicates out- of-lock.

In the transmit mode, modulation from the attenuators in the AFIC (U402-27 and 28) is resistively summed and applied to U201-8. The audio is digitized within U201 and applied to the loop divider to provide the low-port modulation. The audio is also routed through an internal attenuator for balancing of the high and low port modulation, before being applied to the VCO from U201-28.

The AFIC employs switched-capacitor filters which require an external 2.1 MHz clock signal. This clock is generated in U201 by dividing the 16.8 MHz reference oscillator. The signal, at U201- 11, is filtered, attenuated, and applied to U402-43 at a level of approximately 2 Vp-p.

Synthesizer

The Fractional-N synthesizer uses a 16.8 MHz crystal (Y201) to provide the reference frequency for the system. External components C201-3, R201-2, and CR201 are also part of the temperature-compensated oscillator circuit. The dc voltage applied to varactor CR201 is determined by a temperature compensation algorithm within U201, and is specific to each crystal Y201 based on a unique code assigned to the crystal.

The divided frequencies of the reference oscillator and the VCO signal (as applied to U201-20) are compared to generate the necessary correction voltage, or steering line voltage, which maintains the proper VCO frequency. The steering line voltage from U201-29 is filtered and applied to varactors CR241 and CR251 to control the frequencies of the receive and transmit VCOs respectively. To achieve fast lock time, an internal adaptive charge pump provides higher momentary current capability at U201- 31 than in the normal steady-state mode. The normal and adapt charge pumps receive their dc supply from a voltage-multiplier circuit which includes CR211, CR212 and associated capacitors C210-C216. By combining two 5 V square waves which are 180 degrees out-of-phase and adding this to the regulated 5 V supply, a source of approximately 12.6 Vdc is available at U201-32. The current for the normal mode charge pumps is set by R242. The pre-scaler for the loop is internal to U201 with the value determined by the frequency band of operation.

VCO

The VCO (U251) used in conjunction with the Fractional-N synthesizer (U201) generates an RF signal for both receive and transmit modes. The TRB line (U251-5) determines which oscillator and buffer is enabled, as described below. A sample of the RF signal from the enabled oscillator is routed from U251-23 to the prescaler input U201-20 via a matching network. After frequency comparison with the reference in the synthesizer, a resultant control voltage is applied to the varactors CR241 and CR251. This voltage, when locked, is between 3 and 10 V depending on VCO frequency.

In the receive mode, U251-5 is low, enabling the receive VCO and buffer in U251. The RF output signal at U251-2 is further amplified by Q271, low-pass filtered, and matched to the 50 ohm injection port of first mixer U1 at a level of +6 dBm.

During transmit, U251-5 is high, activating the transmit VCO and buffer. The RF output signal at U251-4 is low-pass filtered and matched into Q281 for further amplification before being applied to the RF power amplifier. A resistive attenuator (R284 through R286) isolates the VCO and buffer from impedance variations presented by the power amplifier for improved stability. The power output presented to the first stage (Q2610) of the RF power amplifier is +13 dBm.

Transmit and Receive Audio Circuitry

The majority of Rx and Tx audio processing is performed by U402, the Audio Filter IC (AFIC), which provides the following functions:

- Tone/Digital PL encoding and decoding
- PL rejection filter in Rx audio path
- Tx pre-emphasis amplifier
- Tx audio limiter
- Post-limiter (splatter) filter
- Tx deviation adjust digitally-controlled attenuators
- Programmable microphone gain attenuator
- Carrier squelch digitally-controlled attenuator
- Microcomputer output port expansion
- 2.5 Vdc reference source

The parameters of U402 which are programmable are selected by the microcomputer via the SR CLOCK (U402-39), SR DATA (U402-38) and chip enable (U402-41) lines.

Rx Audio Path

Low-Level Rx Audio

Detected audio from the IFIC U51-31 is routed via C553 to the switchable-gain limiter stage U552. The gain of limiter stage U552 is changed for 12.5 kHz or 25 kHz channels so that its output limits at slightly greater than full system deviation in either case. This limits the loudness of noise relative to voice during fading, weak signal conditions and squelch tails. Output is taken from this stage at two places. Pin 4, which is the (-) input, serves as an output which feeds AFIC ports Rx IN (pin 14) and PL IN (pin 15) via C551. The feedback around the op amp stage maintains the signal at U552-4 exactly equal to the signal applied to the (+) input, but the signal at U554-4 benefits from the selectable noise limiting threshold. Gain adjustments in the receive audio path for 12.5 or 25 kHz channels are then made in the AFIC. A second output from the limiter stage is taken at pin 1 and is affected by the gain change of U552 so that the level is a constant 840 mV rms at 60% deviation for either 12.5 or 25 kHz channels. This level is attenuated 12 dB by R573, R579 and R580 and routed to the Detector Audio Send pin of the AdvantagePort™ connector (J13-16).

Detected audio from the IFIC U51-31 is also routed via a switchable-gain path (R577, R578 and U554A) to analog switch U553B (see "Accessory Connector Rx Audio Path").

The audio applied to the AFIC at U402-14 (Rx IN) is sharply high- pass filtered to remove all PL and DPL tones below 300 Hz. Audio is then routed through a digitally controlled attenuator which is set to approximately 6 dB attenuation. This attenuation is non-adjustable and maintains the output at U402-31 (Rx OUT) at a fixed and defined level of 450 mV rms for 60% deviation, since this level is applied to the AdvantagePort connector (J13-6). Receive volume adjustment is accomplished at a later point using the volume control R554. The internal de-emphasis characteristic within U402 is enabled, with the result that audio at U402-31 is de-emphasized but unmuted.

This audio signal is processed by the option board if present, or passed through resistor R551 if no option board is installed, and then fed to the expander portion of compander IC U555. The operation of the compander is described below. The output from the compander IC is routed through mute gate U554D, amplified by U551A and fed to the volume control, and also to handset audio buffer U551D (see "Handset Audio Path") and analog switch U553B (see "Accessory Connector Rx Audio Path").

Audio Power Amplifier

Audio from the wiper of the volume control is amplified by the audio power amplifier IC U501. This is a bridge amplifier delivering 7.8 V rms between pins 4 and 6 without distortion. This is sufficient to develop 7.5 watts of audio power into an external 8 ohm load, or approximately 4 watts of audio power into an internal 16 ohm speaker (under this condition, undistorted audio output voltage swing exceeds 8 V rms). The audio power amplifier is muted whenever speaker audio is not required, to reduce current drain and eliminate noise in the speaker. The audio amp is muted when U501-8 is low. This occurs if Q501 is saturated (U402-9 high) or when the radio is turned off. The current drain into supply pin U501-7 is negligible when U501-8 is low.

Because the power amplifier is a bridge-type, neither speaker terminal is grounded. Care should be taken that any test equipment used to measure the speaker audio voltage does not ground either speaker output terminal, otherwise damage to the audio power amplifier IC may result. If the test equipment input is not isolated from ground, voltage measurements may be made from one of the speaker output terminals (J3-1 or J3-16) to ground, in which case the voltage indicated will be one half of the voltage applied to the speaker or load resistor. When an 8-ohm load resistor is used, it should be connected across pins 1 and 16 of J13, never to ground.

Handset Audio Path

Rx audio from U551A-1 is amplified by op amp U551D and applied to the microphone connector J5-8 for use with a telephone-type handset. This audio is de-emphasized, and muted by U554D. It is also affected by any receive audio processing circuits on the option board, if installed, and by the compander, if enabled. When the radio has been programmed for handset operation, the audio power amplifier is muted whenever the handset is off- hook by a logic high from U402-9. This silences the speaker when the handset is in use.

Accessory Connector Rx Audio Path

Rx audio is amplified by stage U551B and is available at the accessory connector pin 11. This audio may be one of two types, depending on the RSS programming of analog switch U553B.

If U553B-10 is programmed high, the audio fed to U551B comes from the receiver's detector audio via a switchable-gain path using R577, R578 and U554A. In this case, audio at the accessory connector (J3-11) is "flat" (non-de-emphasized) and unmuted.

If U553B-10 is programmed low, the audio fed to U551B comes from U551A. Audio at J3-11 is de-emphasized and muted. This path will also be affected by any receive audio processing circuits on the option board, if installed, and by the compander, if enabled.

PL Decoder

Detected Rx Audio which has been limited by stage U552 is applied to the AFIC PL IN port (U402-15), where it first passes through the Tone PL filter or Digital PL filter, depending on the PL option selected for the current operating mode. Filtered PL is then coupled to the PL detector circuit, with detected output at U402-35. The detected PL signal is coupled from U402-35 to microcomputer port PA1 (U401- 15) where algorithms perform the final PL decoding. Data for the tone PL frequency or Digital PL code for each mode is programmed through the Radio Service Software.

AdvantagePort™ Internal Option Board Rx Audio Path

De-emphasized, unmuted audio is available at J13-6 for use by an internally installed option board. If this audio is to be processed and returned to the radio's receive audio path, the processed audio will be returned from a low-impedance source on the option board to J13- 8. The unprocessed audio through R551 is shunted due to the low source impedance of the option board at J13-8.

Since the gain of the AFIC is different for 12.5 or 25 kHz channels, the RX audio level at J13-6 is always 450 mV at 1 kHz and 60% deviation, regardless of the channel spacing. Similarly, audio returned to J13-8 from the option board should be supplied at a level of 130 mV rms at 60% deviation, regardless of the channel spacing.

Non-de-emphasized, unmuted audio is available at J13-16. Options requiring non-de-emphasized audio may use this, or may re-pre- emphasize the audio at J13-6, depending on the design of the option board. Because the gain of stage U552 is different for 12.5 or 25 kHz channels, the RX audio level at J13-16 is always 210 mV at 60% deviation, regardless of the channel spacing.

Noise Squelch Attenuator

The AFIC contains a 16 step programmable digital squelch attenuator whose input is U402-23 and output is U402-26. Noise squelch sensitivity is set using RSS, with open squelch at step 0 and maximum (tight) squelch at step 15.

Tx Audio Path

Voice Path via Front Panel

Microphone audio from the front panel mic jack J5-5 is attenuated from 80 mV rms (for 60% deviation at 1 kHz) to 65 mV by R658 and R659. When mic PTT is sensed from J5-6, CMOS gate U554C is enabled by a logic low at U402-5, which is inverted by Q651 to provide a logic high at U554C-6.

This audio is fed to the compander IC where it is amplified from 65 mV to 100 mV by an op amp gain stage (pins 7 and 6) and then applied to the compressor portion of the compander (pin 3). The output (pin 2) is attenuated back to the original 65 mV rms level by another op amp stage (pins 9 and 10) and applied as a low- impedance source to the Tx Audio Send pin of the AdvantagePort connector (J13-10).

Voice Path via Accessory Connector

Microphone audio from an accessory such as a desk set applied to External Mic Audio input J3-2 is attenuated from 80 mV rms (for 60% deviation at 1 kHz) to 65 mV by R666 and R665. When External Mic PTT is sensed at J3-3 (or from any programmable input to which Ext Mic PTT has been assigned), CMOS gate U554B is enabled by a logic high at U401-47.

This audio is fed to the compander IC and processed as described above for the Voice Path via Front Panel.

AdvantagePort™ Internal Option Board Tx Audio Path

Non-pre-emphasized microphone audio is available at J13-10 for use by an internally installed option board. If this audio is to be processed and returned to the radio's transmit audio path, the processed audio will be returned from a low-impedance source on the option board to J13-12 (Tx Audio Return). The unprocessed audio through R654 is shunted due to the low source impedance of the option board at J13-12. Since deviation is adjusted appropriately by the AFIC for 12.5 or 25 kHz channels, the TX audio level at J13-10 and J13-12 is always 65 mV for 60% deviation at 1 kHz, regardless of the channel spacing.

Some option boards must be able to modulate the transmitter with very low frequency data. The Post-Limiter Flat Tx Audio Return pin (J13-2) is used for this application. Audio from this pin is routed to the AUX Tx IN pin on the AFIC (U402-20) via summing op amp stage U551C. A level of 150 mV rms will produce 60% deviation regardless of channel spacing. This path bypasses the limiter stage in the AFIC, therefore the option board must provide the necessary amplitude limiting of this signal to prevent overdeviation. The AUX Tx IN path of the AFIC must be enabled via software control for this path to be active.

Pre-emphasis of Microphone Audio Signals

Pre-emphasis of the front panel or accessory microphone audio signal occurs after the AdvantagePort option board processing has occurred. Series capacitor C651 provides the pre-emphasis characteristic of audio applied to the Tx IN pin of the AFIC (U402-17). This pin is the summing junction of an inverting op- amp gain stage within U402. Audio processing, including limiting, splatter filtering, and level adjustment are performed within U402. The outputs of the two programmable deviation-adjustment attenuators (U402-27 and 28) are resistively summed and applied to the VCO modulation input of the frequency generation system.

Flat (Non-Pre-Emphasized) Tx Audio Path via Accessory Connector

Audio applied at J3-5 may be routed to the transmitter either before the limiter (PRE-LIM) or after (POST-LIM). This is programmed using RSS. The path is controlled by CMOS gate U553C, as controlled by U402-8 (low for PRE-LIM, high for POST-LIM). When the POST-LIM path is chosen, audio is routed via R671 and op amp U551C to the AUX TX INPUT (U402-20), therefore this input of the AFIC must be enabled via software control whenever an accessory connector PTT is sensed at J3-3 (or from any programmable input to which Accessory PTT has been assigned).

If the PRE-LIM path is chosen, audio is coupled by C655 and R670 to the summing input of an op amp within U402 (pin 17). Because R670 is significantly larger than R671, R669 provides a charging path for C655 when the PRE-LIM route is selected which is equivalent to the charging path via R671 in the POST-LIM path.

Audio present at J3-5 is muted during transmitter key-up until the frequency synthesizer has settled and locked on-frequency. This prevents unintentional frequency offset due to the presence of modulation while PTT is keyed. Muting occurs when U401-9 provides a low to U553A-11. While muted, R672 maintains the same dc bias on C655 to prevent switching transients.

Tx Data Encoder (D/A Converter)

Data such as MDC or DTMF signalling can be encoded into the TX audio path by generating the waveform at ports PA3, PA4 and PA5 of U401 (pins 13, 12 and 11 respectively). These outputs are resistively summed and weighted to allow either square waves or pseudo-sinewaves to be encoded. Op amp U551C provides active summing and outputs the signal to the AUX Tx IN port of the AFIC (U402-20). Connection is also made to the AUX Rx IN port (U402- 13) to allow true sidetones to be heard, for example when DTMF tones are encoded. The AUX Tx IN path of the AFIC must be enabled via software control when the data encoder is operating.

The data encoder circuit may not be utilized in all models.

Compander Operation

The compander circuit of U555 is used to improve the signal-to- noise ratio of the voice communications path. This is accomplished by compressing the microphone signal during transmit by a ratio of 2:1 so that a 60 dB range of level changes at the microphone are reduced to only a 30 dB change before being transmitted. A complimentary expander circuit in the receiver audio path restores the 30 dB range of the received signal to its original 60 dB range before being applied to the speaker. Any noise occurring in the over-the-air transmission which is more than 30 dB below full deviation is reduced to greater than 60 dB below the peak voice level at the speaker, making such noise essentially inaudible.

The effectiveness of the compander system requires that both the transmitter and receiver utilize companding. It is possible to program the compander off on a per-channel basis using RSS, for use in systems with other radios that do not have the compander feature. The compander is active when U555-8 is low, and is bypassed when U555-8 is high. When in the bypass mode, the gain of the compressor (pin 3 in, pin 2 out) and expander (pin 14 in, pin 15 out) circuits is unity.

Q553 and C581 keep the compander turned off for approximately one second when the radio is turned on, to allow the compander circuits sufficient time to stabilize. At turn-on, U401-30 pulses low, which turns on Q553 and quickly charges C581 to 5 V, bypassing the compander. If the compander should be on, U401-30 stays high, and C581 discharges due to the internal resistance of U555-8. After one second, the voltage at U555-8 is low enough to enable the compander. If the compander should be off, U401-30 remains low, keeping Q553 on and U555-8 high.

Q554 and Q555 are used to increase the receive audio path gain by approximately 4 dB whenever the compander is turned on. This maintains the same subjective audio level for both compander and non-compander channels.

Public Address Operation

When the public address switch box and amplified speaker(s) accessories are used, and the radio has been programmed by RSS for public address, operation is as follows:

Turning on either the INT PA or EXT PA switches on the public address switch box provides a low at pin 14 of accessory connector J3. This enables public address operation of the radio. In this condition, radio receiver operation is unaffected, but keying of the transmitter is inhibited. If a MIC PTT is sensed from microphone jack J5-6, both the INT MIC ENABLE and EXT MIC ENABLE lines go high (U402-5 is low and U401-47 is high). This turns on both mic audio gates U554C and U554B, and allows audio from the microphone jack J5-5 to be routed directly to accessory connector J3-2. Mic audio from J3-2 is then routed to the selected public address amplified speakers by the public address switch box.

To prevent loading of the mic audio signal and loss of low frequency response, U651 senses that both INT MIC and EXT MIC enable lines are high and provides a low at its output, turning off U652 and removing the loading of R665 from the audio path. At all other times, U652 is on to provide microphone bias voltage to the external mic input via R665.

Transmitter Circuitry

VHF 10-25 Watt Transmitter RF Power Amplifier

The 10-25 watt VHF power amplifier is designed to cover the range of 150-170 MHz. It consists of three stages. The first stage, Q2410, operates in Class A with base bias supplied by the 8T source. The collector voltage is supplied from controlled B+. The output level of this stage (i.e. the gain of this device) is varied by changes in the controlled B+ voltage. The magnitude of the control voltage depends on the PA output power, temperature and also antenna load mismatch.

The second stage of the PA, Q2430, is the driver which amplifies the output of low level amplifier to a level sufficient to drive the final stage device. This device operated in Class C delivers up to 3 watts output power. Collector voltage is supplied by UNSWB+.

The third stage, Q2440, is the final RF power amplifier, which operates in Class C directly from UNSWB+. It provides up to 30 watts output power.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2480 (forward power) and CR2481 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2450 and CR2451. L2452 and C2450, combined with the "on" inductance of CR2451, form a series resonant circuit to lower the shunt impedance presented by CR2451 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2451 and C2453 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitter RF from Q2440 via the directional coupler is routed through CR2450, and via the harmonic filter to the antenna jack. CR2451 conducts, shunting RF power and preventing it from reaching the receiver. L2451 is selected to appear as a 1/4 wave at VHF, so that the low impedance of CR2451 appears as a high impedance at the junction of CR2450 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

During transmit mode, 8T is present and both diodes are forward biased into conduction. The transmitter RF from Q2640 via the directional coupler is routed through CR2650, and via the harmonic filter to the antenna jack J1. The PIN diode CR2651 in the shunt-leg conducts, shunting RF power and preventing it from reaching the sensitive receiver front-end. The impedance inverter network contributes approximately 30 dB to transmit/receive isolation. Whereas, during receive mode, both the PIN diodes are non-conducting. Thus, the signal applied at the antenna jack J1 are routed via the harmonic filter, through C2658, L2652 and C2659 to the receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebychev low pass filter with a 3 dB frequency of approximately 200 MHz and less than 1 dB insertion loss in the passband.

VHF 40 Watt Transmitter RF Power Amplifier

The 40 watt VHF power amplifier is designed to cover the range of 150-174 MHz and has four stages. The first stage, Q2410, operates in Class A from the 8T source. It provides 13 dB of gain and an output of 400 mW.

The second stage, Q2420, has a nominal gain of 9.4 dB and power output of up to 3.5 watts. The output of this stage is adjusted by the controlled B+ voltage which supplies its collector. (VB+ max = 6.55 V).

The third stage, Q2430, operates in Class C with 8.1 dB gain and output power up to 22 watts. Collector voltage is directly from UNSW B+.

The fourth stage, Q2440, is the final RF power amplifier, which operates in Class C, is directly from UNSW B+. It provides up to 65 watts output.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2480 (forward power) and CR2481 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2450 and CR2451. L2452 and C2450, combined with the "on" inductance of CR2451, form a series resonant circuit to lower the shunt impedance presented by CR2451 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2451 and C2453 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitter RF from Q2440 via the directional coupler is routed through CR2450, and via the harmonic filter to the antenna jack. CR2451 conducts, shunting RF power and preventing it from reaching the receiver. L2451 is selected to appear as a 1/4 wave at VHF, so that the low impedance of CR2451 appears as a high impedance at the junction of CR2450 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebychev low pass filter with a 3 dB frequency of approximately 200 MHz and less than 1 dB insertion loss in the passband.

UHF 10-40 Watt Transmitter RF Power Amplifier

The 40 watt UHF power amplifier is designed to cover the range of 450-474 MHz and has four stages. The first stage, Q2610, operates in Class A from the 8T source. It provides 11.8 dB of gain and an output of 300 mW.

The second stage, Q2620, has a nominal gain of 8.2 dB and power output of up to 2 watts. The output of this stage is adjusted by the controlled B+ voltage which supplies its collector.

The third stage, Q2630, operates in Class C with 8.1 dB gain and a power output of up to 13 watts. Collector voltage is directly from UNSW B+.

The fourth stage, Q2640, is the final RF power amplifier, which operates Class C directly from UNSW B+. It provides up to 30 watts output for low power and 50 watts output for high power.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2680 (forward power) and CR2681 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2650 and CR2651. L2652 and C2650, combined with the "on" inductance of CR2651, form a series resonant circuit to lower the shunt impedance presented by CR2651 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2651, C2653, and L2664 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitter RF from Q2640 via the directional coupler is routed through CR2650, and via the harmonic filter to the antenna jack. CR2651 conducts, shunting RF power and preventing it from reaching the receiver. L2651 is selected to appear as a 1/4 wave at UHF, so that the low impedance of CR2651 appears as a high impedance at the junction of CR2650 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebychev low pass filter with a 3 dB frequency of approximately 600 MHz and less than 1 dB insertion loss in the passband.

Power Control Circuit

The power control circuit is a dc-coupled amplifier whose output is the controlled voltage applied to the second stage of the RF power amplifier (Q2420 in 40 W VHF, Q2410 in 25 W VHF, or Q2620 in UHF).

The input voltage to U451A-2 is a dc voltage from the directional coupler forward power detector, and is proportional to RF power output. This is compared to a dc voltage applied to U451A-3 which is proportional to the desired output power setting. This voltage is obtained by integrating a series of square wave pulses from port PH1 of the microprocessor (U401-26). The duty cycle of these pulses is varied in proportion to the desired output power setting. Components R458, C467, R457 and C458 integrate the PWM pulses into a smooth dc voltage.

The power control loop varies the output of stage Q2420 or Q2620 as necessary to keep equal voltages at U451A pins 2 and 3, and thus maintains forward power at the adjusted setting.

Under conditions of poor antenna match resulting in high reflected power, the dc voltage at U451A-3 is reduced due to a lowering of the voltage at U451B-7. This is interpreted by the power control circuit as a lowering of the desired output power.

The temperature-sensing circuit protects the PA devices from excessively high temperatures. As the PA temperature increases, the resistance of thermistor R462 decreases. This causes Q453 to conduct, reducing the voltage at the base of Q452. This reduces the conduction of series pass device Q451, lowering the control voltage and therefore the output power.

Over-voltage protection prevents the control voltage from rising so high that the subsequent transmitter stages may be overdriven. Zener diode VR451 conducts when the control voltage exceeds 5.3 V in 40 W VHF models or 10.6 V in UHF models. This causes Q453 to conduct, lowering the control voltage as described earlier.

PTT Circuits

The logic system uses a single microcomputer A/D input port PE1 (U401-36) to distinguish between two different types of PTT information. This is done by assigning different voltage levels to the different PTT functions as follows:

0 to 2.1 Vdc (0.6 Vdc typ): Microphone PTT

2.2–3.6 Vdc (2.6 Vdc typ): Accessory PTT

4.75 to 5.0 Vdc (5.0 Vdc typ): Receive Mode

A microphone connected via the front panel jack J5 must present a low of less than approximately 2.0 V dc to be correctly interpreted as MIC PTT and cause the appropriate audio paths to be enabled. Similarly, an accessory whose PTT output is connected to J3-3 must present a low of less than approximately 2.0 V dc to be interpreted as an accessory PTT. This voltage is shifted to the range between 2.2 and 3.6 V by series resistor R432.

Some accessories connected to J3 need to sense microphone PTT by looking for a low at J3-3. Diode CR408 causes J3-3 to be pulled low whenever microphone connector J5-6 is low.

Programmable I/O's

Pins 4, 6, 8, 9, 12, and 14 are programmable I/O's. They are used to control external accessories by the radio, or for control of radio functions by accessories.

Pin 4 is an output only. When U401-21 is high, Q901 and Q902 are on, and pin 4 is pulled high to the battery voltage. This is normally used to turn on a relay for activating the vehicle's horn or lights.

Pin 6 is an input only. Normally, R905 pulls pin 6 high, turning on Q903 and pulling U401-45 low. If pin 6 is pulled low, U401-45 goes high.

Pin 8 is an I/O (input and output). To function as an input, Q905 is turned off by keeping U401-20 low. Then, R907 pulls pin 8 high, turning on Q904 and pulling U401-44 low. If pin 8 is pulled low, U401-44 goes high. To function as an output, Q905 pulls pin 8 low whenever U401-20 is high.

Pin 9 is an input only. Normally, R909 pulls pin 9 high, turning on Q906 and pulling U401-46 low. If pin 9 is pulled low, U401-46 goes high. The emergency switch accessory, if used, is connected here.

Pin 12 is another I/O. To function as an input, Q909 is turned off by keeping U401-19 low. Then, R913 pulls pin 12 high, turning on Q908 and pulling U401-43 low. If pin 12 is pulled low, U401-43 goes high. To function as an output, Q909 pulls pin 12 low whenever U401-19 is high.

Pin 14 is also an I/O. To function as an input, Q911 is turned off by keeping U401-22 low. Then, R915 pulls pin 14 high, turning on Q910 and pulling U401-42 low. If pin 14 is pulled low, U401-42 goes high. To function as an output, Q910 pulls pin 14 low whenever U401-22 is high.

Zener diodes and bypass capacitors on each programmable I/O line prevent damage or abnormal operation due to ESD transients or RF fields.

The extent to which programmable I/O functions are supported may vary with different radio models. RSS allows the functions which are supported to be programmed.

DC Regulation and Distribution

Unswitched B+ supplies operating voltage directly to the RF power amplifier third and fourth stages, the power control series pass device Q451-E, the RAM keep-alive constant voltage supply to U401-62, the audio power amplifier supply pin U501-7 and, via fuse F401, to the on-off switch and external alarm switch transistor Q902-E. All of these circuits draw negligible current when the radio is turned off (less than 15 mA total).

When the on-off switch is "on," battery voltage is applied to 8 volt regulator U406, and via R502 to pin 8 of the audio power amplifier U501 which turns it on unless muted by Q501. The regulated output of U406 is routed to the display board for backlighting, to 8T transistor switch Q414, to U51 pins 16 and 17, to op amp U551 supply pin 4, and to the inputs of the 5 volt regulators U404 (digital) and U405 (analog). Separate analog and digital regulators are used to minimize microcomputer noise from being introduced into sensitive VCO and receiver circuits. The digital 5 V regulator includes a reset timer which hold the reset line U404-3 low for a predetermined time after the radio is turned on. Zener diodes on the 8 V and digital 5 V lines minimize susceptibility to ESD damage.

Ignition control of the radio is accomplished by removing fuse F401. The radio will only be able to turn on if battery voltage from the vehicles ignition switch is applied to accessory connector J3 pin 10. This voltage is routed to the on-off switch.

20-Channel LCD Front Panel Display Board

The 8-character display board contains back lighting LED's, and an LCD that is driven by the LCD driver IC, U1101. When the LCD driver, U1101, is enabled via the CE (Chip Enable) input, the desired display information is then loaded serially via the SR Data line into U1101 from the microprocessor. U1101 also has a clock input that is connected to the main board SR Clock.

The back lighting for the 8-character display board can be toggled between two colors, amber and green per the users choice. This color choice for the LED's is controlled by the microprocessor, which in turn gets its input from either the RSS setup, or one of the pushbuttons if so enabled. Each color of back lighting is produced by 12 pairs of LED's, which are turned on by applying a ground to the cathodes of the 12 pairs of LED's.

To enable the amber LED's, a DC level of 5 V from the microprocessor is applied to the base of Q1108. This 5 V saturates Q1108 which connects a ground to the amber LED cathodes and also the base of Q1107. With the base of Q1107 grounded, the transistor operates in the cutoff mode which leads to the collector having a potential of ~8 V, which is also applied to the cathode of the green LED's.

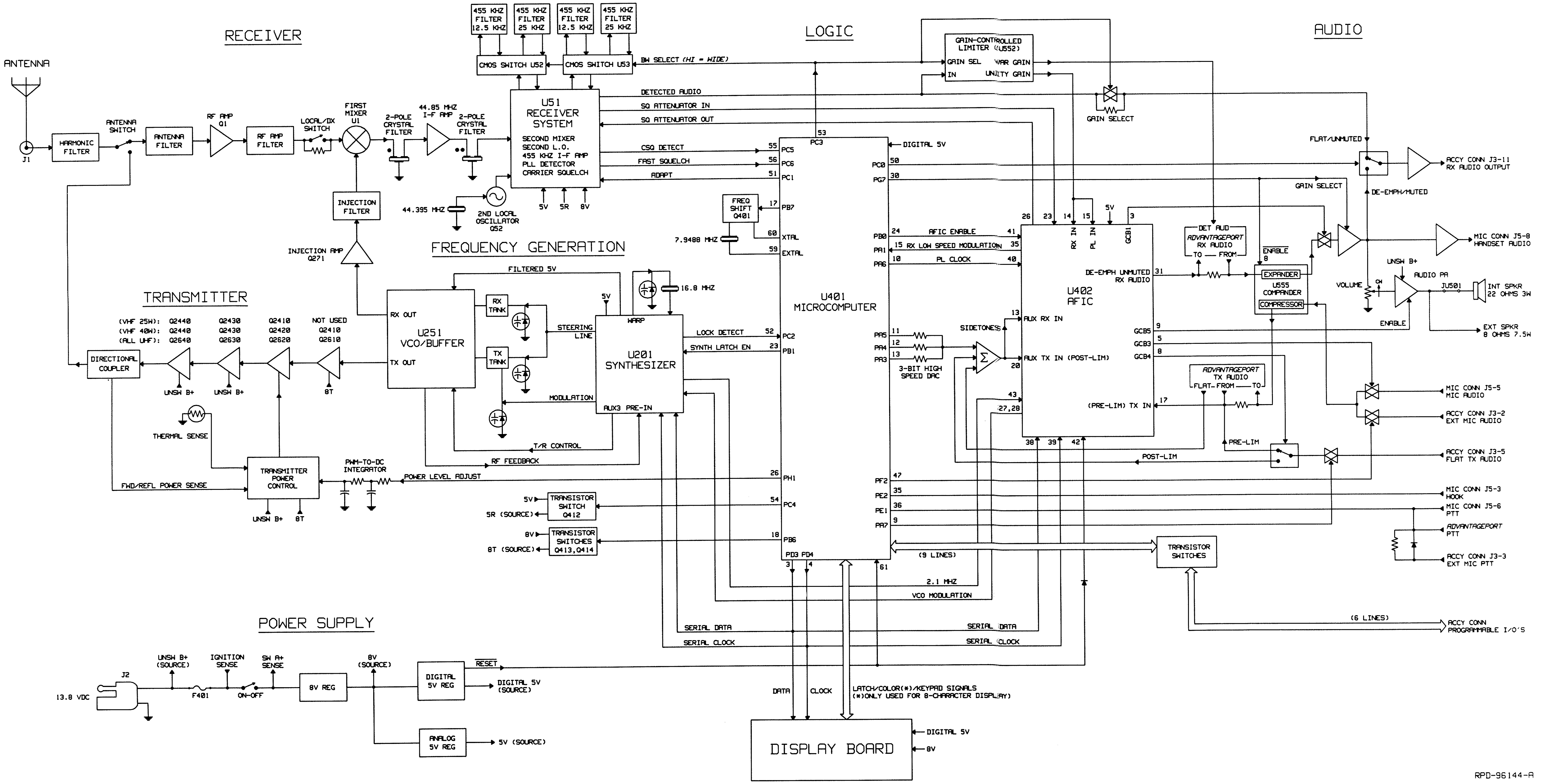
To enable the green LED's, a DC level of 0 V (ground) to the base of Q1108 keeps Q1108 in cut-off mode which leads to the collector of Q1108 having a potential of 8 V. This 8 V potential on the collector of Q1108 is also applied to the base of Q1107 via R1125, thus saturating Q1107 and connecting the green LED's to ground.

The six pushbuttons apply voltage to the bases of six digital transistors, Q1101 through Q1106. The appropriate transistor, in turn, grounds a tap on the series resistor ladders R1117 through R1122, producing a different DC level depending on which button is pressed. These DC levels are interpreted by an A/D input of the microprocessor (U401-37) and the corresponding function is enabled. The transistors ensure that the DC ladder voltage is consistent, although the series resistance of the keypad may vary.

4-Channel LED Front Panel Display Board

The LED display board contains back lighting LEDs for the keypad, channel indicator LEDs; and status indicators for transmit, monitor, and options. The channel and status display information is loaded serially into the shift register, U101. This information is then latched and turns on the LEDs, DS101 - DS105 and DS1012 - DS1014 via the driver transistors, Q1001 - Q1008.

The six pushbuttons apply voltage to the bases of six digital transistors, Q1009 through Q1014. The appropriate transistor, in turn, grounds a tap on the series resistor ladders R1017 through R1022, producing a different DC level depending on which button is pressed. These DC levels are interpreted by an A/D input of the microprocessor (U401-37) and the corresponding function is enabled. The transistors ensure that the DC ladder voltage is consistent, although the series resistance of the keypad may vary.



M1225 Mobile Functional Block Diagram

MMR-128

Radius®

Table of Contents

Note: This page is the beginning of the original manual. All prior pages are MMR-128 pages.

Foreword

Section 1
Radio Disassembly/Assembly

Section 2
Theory of Operation

Section 3
Troubleshooting

Section 4
Expanded Accessory Connector

Circuit Board Details, Schematic Diagrams, and Parts Lists

Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. It contains all service information required for the equipment described and is current as of the printing date. Changes which occur after the printing date are incorporated by service manual revisions. These revisions are added to the manuals as the engineering changes are incorporated into the equipment.

How to Use This Manual

This manual contains introductory material such as model charts, accessories, and specifications, as well as four sections that deal with specific service aspects of the M1225 Mobile Radio. Refer to the Table of Contents for a general overview of the manual, or to the "Overview" paragraph in each section for a specific overview of the information in that section.

Other Documentation

Table 1 lists other documentation for the M1225 Mobile Radio.

Table 1. Other Documentations

Information	Location
Basic Use of Radio	M1225 20-Channel Operator Guide (6880904Z85)
Basic Use of Radio	M1225 4-Channel Operator Guide (6880906Z68)
Accessories	M1225 Accessory/Feature Sheet (6880904Z98)
Installation and Licensing	M1225 Installation/Licensing Guide (6880905Z15)
Programming	1225 Series RSS Getting Started (6880904Z93)

Technical Support

To obtain technical support, you may call Motorola's Radius Product Services. When you call, we ask that you have ready the model and serial numbers of the respective radio or its parts.

Service Policy

If malfunctions occur within 30 days that cannot be resolved over the phone with Radius Product Services, a defective major component should be returned. You must obtain authorization from Radius Product Services before returning the component.

Ordering Replacement Parts

You can order additional components and some piece parts directly through your Radius price pages. When ordering replacement parts, include the complete identification number for all chassis, kits, and components. If you do not know a part number, include with your order the number of the chassis or kit which contains the part, and a detailed description of the desired component. If a Motorola part number is identified on a parts list, you should be able to order the part through Motorola Parts. If only a generic part is listed, the part is not normally available through Motorola. If no parts list is shown, generally, no user serviceable parts are available for the kit.

Radius 30-Day Warranty
Technical Support
Radius Product Services
1000 W. Washington St.
Mt. Pleasant, IA 52641 USA

Motorola Radio Support Center
Attention: Warranty Return
3760 South Central Avenue
Rockford, IL 61102 USA
1-800-227-6772 (U.S. & Canada)

Radius Major Component Repair
Motorola Radio Support Center
3760 South Central Avenue
Rockford, IL 61102 USA

Motorola Accessory & Aftermarket Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Motorola Accessory & Aftermarket Division
Attention: International Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Customer Service
1-800-422-4210
1-847-538-8198 (FAX)

Parts Identification
1-847-538-0021
1-847-538-8194 (FAX)

Model Charts

MODEL	FREQ.	DESCRIPTION
M43DGC90J2AA	20	12.5/25 kHz, 25-40 W

M1225
20-Channel
VHF Mobile Radio
150 - 174 MHz
25-40 Watts RF Power

ITEM	DESCRIPTION
HLN9644_	Display Board (20-Freq.)
HLN9268_	Hardware Kit
(See Note)	Main Board, 12.5/25 kHz, 25-40 W

M43DGC90J2AA	Item	Description	HLN9644_	HLN9268_	(See Note)
X	HUD3233_	Radio, 12.5/25 kHz, 25-40 W	X	X	X
X	HMN3008_	Microphone			
X	HLN9154_	Non-Locking Bracket			
X	HKN4137_	Power Cable			
X	HLN9155	M1225 20-Channel Manual Kit			

Note: Main board kits are not available separately for field replacement

M1225 20-Channel UHF Mobile Radio 450 - 474 MHz 10-25 Watts RF Power & 25-40 Watts RF Power

MODEL	FREQ.	DESCRIPTION
M44DGC90J2AA	20	12.5/25 kHz, 25-40 W
M34DGC90J2AA	20	12.5/25 kHz, 10-25 W

ITEM	DESCRIPTION
HLN9644_	Display Board (20-Freq.)
HLN9268_	Hardware Kit
(See Note)	Main Board, 12.5/25 kHz, 25-40 W
(See Note)	Main Board, 12.5/25 kHz, 10-25 W

M44DGC90J2AA	M34DGC90J2AA	Item	Description	HLN9644_	HLN9268_	Main Board, 25-40 W	Main Board, 10-25 W
X		HUE3873_	Radio, 12.5/25 kHz, 25-40 W	X	X	X	
	X	HUE3817_	Radio, 12.5/25 kHz, 10-25 W	X	X		X
X	X	HMN3008_	Microphone				
X	X	HLN9154_	Non-Locking Bracket				
X	X	HKN4137_	Power Cable				
X	X	HLN9155	M1225 20-Channel Manual Kit				

Note: Main board kits are not available separately for field replacement

M1225 4-Channel VHF Mobile Radio 150 - 174 MHz 25-40 Watts RF Power

MODEL	FREQ.	DESCRIPTION
M43DGC90E2AA	4	12.5/25 kHz, 25-40 W

ITEM	DESCRIPTION
HLN9887_	Display Board (4-Freq.)
HLN9268_	Hardware Kit
(See Note)	Main Board, 12.5/25 kHz, 25-40 W

M43DGC90E2AA	Item	Description	HLN9887_	HLN9268_	(See Note)
X	HUD3251_	Radio, 12.5/25 kHz, 25-40 W	X	X	X
X	HMN3008_	Microphone			
X	HLN9154_	Non-Locking Bracket			
X	HKN4137_	Power Cable			
X	HLN9893	M1225 4-Channel Manual Kit			

Note: Main board kits are not available separately for field replacement

M1225 4-Channel UHF Mobile Radio 450 - 474 MHz 25-40 Watts RF Power & 10-25 Watts RF Power

MODEL	FREQ.	DESCRIPTION
M44DGC90E2AA	4	12.5/25 kHz, 25-40 W
M34DGC90E2AA	4	12.5/25 kHz, 10-25 W

ITEM	DESCRIPTION
HLN9887_	Display Board (4-Freq.)
HLN9268_	Hardware Kit
(See Note)	Main Board, 12.5/25 kHz, 25-40 W
(See Note)	Main Board, 12.5/25 kHz, 10-25 W

M44DGC90E2AA	M34DGC90E2AA	Item	Description	HLN9887_	HLN9268_	Main Board, 12.5/25 kHz, 25-40 W	Main Board, 12.5/25 kHz, 10-25 W
X		HUE3579_	Radio, 12.5/25 kHz, 25-40 W	X	X	X	
	X	HUE3580_	Radio, 12.5/25 kHz, 10-25 W	X	X		X
X	X	HMN3008_	Microphone				
X	X	HLN9154_	Non-Locking Bracket				
X	X	HKN4137_	Power Cable				
X	X	HLN9893	M1225 4-Channel Manual Kit				

Note: Main board kits are not available separately for field replacement

Accessories

Radius offers several accessories to increase communications efficiency. Many of the accessories available are listed below, but for a complete list, consult your Radius dealer.

Antennas:

HAD4006_R	VHF 136-144 MHz, 1/4 Wave Roof Mount
HAD4007_R	VHF 146-150 MHz, 1/4 Wave Roof Mount
HAD4008_R	VHF 150-162 MHz, 1/4 Wave Roof Mount
HAD4009_R	VHF 162-174 MHz, 1/4 Wave Roof Mount
HAD4014_R	VHF 140-174 MHz, 3 dB Gain Roof Mount
RAD4000_MB	VHF 140-174 MHz, 3 dB Gain Magnetic Mount
HAE4003_R	UHF 450-470 MHz, 1/4 Wave Roof Mount
HAE4004_R	UHF 470-512 MHz, 1/4 Wave Roof Mount
HAE4011_R	UHF 450-470 MHz, 3.5 dB Gain Roof Mount
HAE4012_R	UHF 470-494 MHz, 3.5 dB Gain Roof Mount
RAE4004_RB	UHF 450-470 MHz, 5 dB Gain Roof Mount
RAE4004_MB	UHF 440-470 MHz, 5 dB Gain Magnetic Mount
HKN9557_R	PL259/Mini-U Antenna Adapter with 8 in. Cable
HLN5282_R	Mini-U Connector
HLN8027_	Mini - UHF to BNC Adapter

Microphones:

HMN1035_R	Heavy Duty Palm Microphone with 10.5 ft. Cord
HMN3008_	Compact Microphone with Tx LED, 7 ft. Cord & Hang-up Clip
HMN3001_	Compact Microphone with Tx LED, 10 ft. Cord & Hang-up Clip
HMN3175_	Compact Touch-Code™ Microphone, 7 ft. Cord & hang-up Clip
HMN3174_	Compact Micophone with Tx LED, 7ft. Cord & Hang-up Clip
HMN3141_R	Handset with Hang-up Cup
HLN9073_R	Microphone Hang-up Clip
HLN9414_	Universal Hang-Up Clip
HLN9560_R	10.5 ft. Extended Coil Cord
HLN9559_R	7 ft. Coil Cord

Installation Accessories:

HLN9162_	5 in. Goose Neck Mounting Bracket
HLN9227_	8 in. Goose Neck Mounting Bracket
HLN9408_	Goose Neck Decor Sleeve
HLN9534_	Right Angle Mini-UHF Connector
HLN9228_	Clam Shell Swivel Mounting Bracket
HLN9617_	Key Lock Mounting Bracket
HLN9154_	Non-Locking Mounting Bracket
HLN9179_	Quick Release Mounting Bracket
HLN9573_R	Shorting Plug
HKN4137_	Low Power Cable to Battery

Control Station Accessories:

HLN9226_	Mobile Holder
HLN9886_	Grounding Kit
HMN3000_	Black Desk Microphone
HKN9018_	Control Station Cable
HKN9019_	16-pin Conductor Cable
HPN8393_	Power Supply
HPN9012_	Power Supply (25 W only)
HKN9088_	Mini_U Antenna Adapter

Accessories / Kits Interfacing with the 16-Pin Connector:

HKN9242_	16-pin Accessory Kit with Expanded Connector
HSN9008_	16-pin External Speaker for Received Audio, 7.5 W
HLN3145_R	Public Address Kit
HSN1000_R	Amplified External Speaker, 6 W

Accessories

HKN9327_R	16-pin Ignition Switch Cable
HLN9328_R	External Alarm Relay and Cable for Horn & Lights
HKN9324_	15 ft. Public Address Speaker Cable
HKN9407_	Cigarette Lighter Adapter w/LED Indicator (25 W only)

Manuals/Kits:

L1547A	DC Remote Adapter Manual
L1475A	Tone Remote Adapter Manual
6880904Z04	DTMF Microphone Operator's Instructions
6880904Z05	DTMF Microphone Service Manual
HLN9155	M1225 20-Channel Manual Kit
HLN9893	M1225 4-Channel Manual Kit
HVN9054	M1225 Radio Service Software Kit

Specifications

GENERAL

	VHF		UHF	
Model Series:	M43DGC		M44DGC, M34DGC	
Frequency Range:	150-174 MHz		450-474 MHz	
RF Output:	25-40W		10-25 & 25-40 WW	
Channel Spacing:	12.5 kHz	20/25/30 kHz	12.5 kHz	20/25 kHz
Dimensions:	H 1.73" X W 6.61" X D 4.25" (H 44mm X W 168mm X D 108mm)			
Weight:	36 oz. (1.02kg)			
Channel Capacity:	20 or 4 Channels			
Freq. Separation:	24 MHz			
Input Voltage:	13.6 ±10%			
Current Drain: Standby Receive @Rated Audio	300 mA 1.5 A			
Transmit	12.5 A @ 40 W		12.5 A @ 40 W	
Squelch Capabilities:	Tone Coded, Digital Coded and/or Carrier Squelch			

TRANSMITTER

	VHF	UHF
Freq. Stability (-30C to +60C):	±0.00025%	
Spurs/Harmonics:	-23 dBm (5 µW)	
Audio Response:*	+1/-3 dB, relative to 6 dB/octave pre-emphasis, 300-3000 Hz (2550 Hz @ 12.5 kHz)	
FCC Designation:	ABZ99FT3037	ABZ99FT4044, ABZ99FT3038
FCC Modulation: 20/25/30 kHz 12.5 kHz	16K0F3E 11K0F3E	16K0F3E 11K0F3E
Output Impedance:	50 ohms	
Modulation Sensitivity:	80 mV rms for 60% deviation @ 1000 Hz	
FM Noise: 20/25/30 kHz 12.5 kHz	45 dB 40 dB	40 dB 35 dB
Audio Distortion:	<3% EIA (@1000 Hz, 60% of Rated Max. Deviation)	

RECEIVER

	VHF		UHF	
	12.5 kHz	**25 kHz**	**12.5 kHz**	**25 kHz**
Freq. Stability (-30C to +60C):	±0.00025%			
Sensitivity TIA @ 12 dB SINAD:	0.35 µV	0.30 µV	0.35 µV	0.30 µV
Squelch (internally pre-set):	10 dB SINAD			
Selectivity TIA:	65 dB	75 dB	60 dB	70 dB
Intermodulation TIA*:	65 dB	75 dB	60 dB	70 dB
Spurious Rejection:	75 dB		70 dB	
Image / Half IF Rejection:	70 dB		70 dB	
Audio Output: 8 ohms (external) 16 ohms (internal)	7.5 W @ 5% distortion 4.0 W Nominal			
Input impedance:	50 ohms			
TIA Usable Bandwidth:	1.2 kHz	2 kHz	1.2 kHz	2 kHz

* Local mode adds 10 dB protection against wideband interference.

MILITARY STANDARDS 810 C, D & E FOR MOUNTING ACCESSORIES

Applicable MIL-STD	Required Mounting Accessory	810C		810D		810E	
		Method	Procedures	Method	Procedures	Method	Procedures
Vibration:	Standard Non-Locking Bracket	514.2	8	514.3	1	514.4	1
Shock:	Standard Non-Locking Bracket	516.2	1, 3	516.3	1	516.4	1
Crash Hazard	Any M1225 Mounting Accessory	516.2	3	516.3	5	516.4	5

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Service Aids

The following table lists service aids recommended for working on the M1225 Mobile Radio.

Motorola Part No.	Description	Application
HLN9214	Radio Interface Box	Enables communication between the radio and the computer's serial communications adapter.
HSN9412	RIB Power supply	Used to supply power to the RIB.
HKN9216 HKN9215	Computer Interface cable	Connects the computer's serial communications adapter to the RIB.
HLN9390	AT to XT Computer adapter	Allows HKN9216 to plug into a XT style communications port.
HKN9217	Program Test Cable	RIB to Radio Cable
HKN9402	Power Supply Cable	Connects the power supply to the radio.
HVN9054	Radio Service Software	Software on 3-1/2 in. diskettes.

Test Equipment

The following table lists test equipment required to service the M1225 Mobile Radio and other two-way radios.

Motorola Model No.	Description	Characteristics	Application
R2200, R2400, or R2001 with trunking option	Service Monitor	This monitor will substitute for items with an asterisk *	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
*R1049	Digital Multimeter		Two meters recommended for ac/dc voltage and current measurements
*S1100	Audio Oscillator	67 to 200 Hz tones	Used with service monitor for injection of PL tones
*S1053, *SKN6009, *SKN6001	AC Voltmeter, Power Cable for meter, Test leads for meter	1mV to 300V, 10-Megohm input impedance	Audio voltage measurements
R1053	Dual-trace Oscilloscope	20 MHz bandwidth, 5mV/cm - 20V/cm	Waveform measurements
*S1350, *ST1215 (VHF) *ST1223 (UHF) *T1013	Wattmeter, Plug-in Elements (VHF & UHF), RF Dummy Load	50-ohm, ± 5% accuracy 10 Watts, maximum 0-1000 Mhz, 300W	Transmitter power output measurements
S1339	RF Millivolt Meter	100uV to 3V RF, 10 kHz to 1.2 GHz	RF level measurements
*R1013	SINAD Meter		Receiver sensitivity
S1347 or S1348 (prog)	DC Power Supply	0-20 Vdc, 0-5 Amps	Bench supply for 12.5Vdc

Section 1
Radio Disassembly/Assembly

Overview

This section explains, step-by-step, how to disassemble and reassemble the M1225 radio.

Disassemble Radio

IMPORTANT
Before disassembling and reassembling the radio, wear a conducting wrist strap to prevent damage to any component on the main board from electrostatic discharge.

Remove Housing Cover

1. Pull the volume control knob straight off.
2. Remove the housing cover by sliding a flat bladed screwdriver under the cover latch (located bottom of radio) and gently pry upward until the latch disengages. (Figure 1-1.)
3. Slide the housing cover off of the heatsink rails.

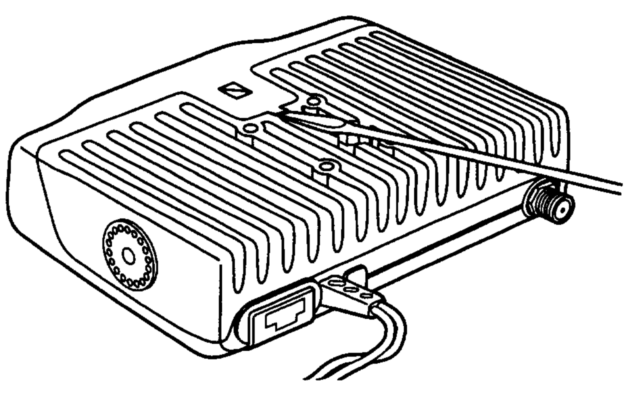


Figure 1-1. Remove Housing

Remove Front Panel Display Board

1. Disconnect the flex connector cable from the black header on the main board by gently lifting upwards.
2. Remove the display board by tilting forward slightly and gently lifting upwards.

Remove Mechanical Components from Main Board

Refer to Figure 1-2 for steps 1 through 8 for the removal of the mechanical components from the main board. Refer to the exploded mechanical view diagram for more details.

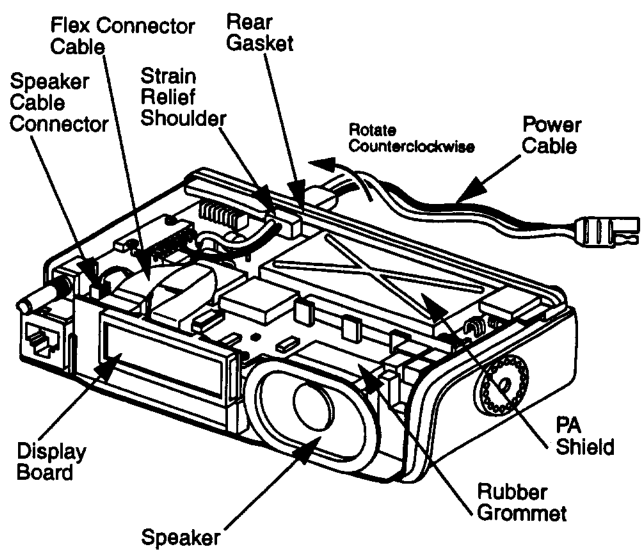


Figure 1-2. Mechanical Components

1. Pull the 2-pin speaker cable connector upwards to disconnect from the main board.

CAUTION
In order to avoid damage to the speaker, *Do Not* grasp the speaker cone when removing the rubber gasket/speaker from the heatsink.

2. Grasp the speaker at both edges and slide the rubber grommet/speaker upwards to remove from the heatsink.
3. On the rear gasket, pry the plug out of the square pocket.
4. Lift up the accessory connector flap located on rear of heatsink.
5. Lift and peel off the rear gasket from the heatsink.

6. Disengage the power cable, from the double-D slot of the heatsink, by grasping and rotating the strain relief shoulder away from the PA shield (counterclockwise) and sliding upwards.

7. Remove the shroud by unsnapping the catch-tabs, located on the heatsink's inside wall, using a flat bladed screwdriver and firmly pulling the shroud away from the heatsink.

8. Gently pry off the PA shield cover using a flat bladed screwdriver.

Remove Main Board

1. Remove the Hex nut from the bottom of the heatsink using a 5/16" nut driver.

2. Remove all 14 mounting screws from the main board using a T10 Torx® driver, being careful not to lose the display board support.

3. Loosen the antenna connection using a 1/2" nut driver.

4. To remove the main board grasp the edge of the main board, the antenna connector, the microphone connector, and the 16-pin accessory connector using both hands and lift upwards and away from heatsink.

CAUTION
Make sure to avoid damaging the PA stud on the underside of the main board when lifting it upwards and away from the heatsink.

Reassemble Radio

Replace Main Board

1. Carefully place the main board into the heatsink, making sure that the PA stud clears the hole on the bottom of the main board.

NOTE
Make sure that the internal tooth washer and nut of the mini-U connector are on the outside of the heatsink wall.

2. Replace the 14 mounting screws and the display board support (refer to Figure 1-3) into the main board using a T10 Torx driver. Torque the 2 screws on the audio PA and the 2 screws on the transistor and regulator at 6-8 in-lbs. Torque the remaining 10 screws at 8-10 in-lbs.

3. Press down on the antenna connection and tighten using a 1/2" nut driver and torque at 20-24 in-lbs..

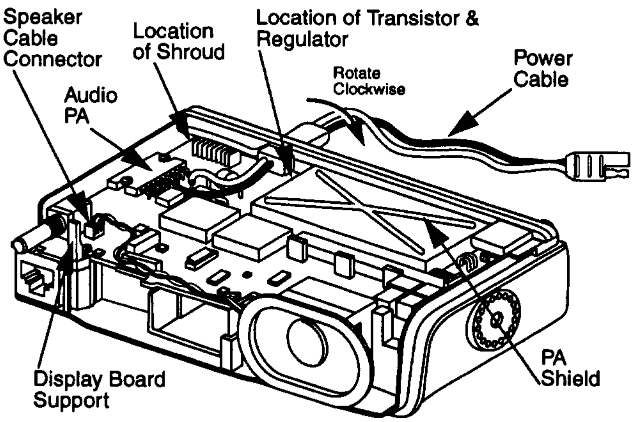


Figure 1-3. Position of Speaker Cable

Replace Mechanical Components to Main Board

1. Rotate the strain relief shoulder away from the PA shield and insert into the double-D slot in heatsink

2. Press the strain relief shoulder downward and rotate (clockwise) toward the PA shield until it is fully seated.

CAUTION
The power cable should be routed around the components properly and gently pressed into position (Figure 1-3).

3. Insert the shroud into the heatsink and press the catch-tabs onto the snaps.

4. Place the rear gasket onto the heatsink, making sure it fits between the wall of the heatsink and the PA frame while firmly pressing the five ribs into the five teardrop indentations on the heatsink.

5. Press the plug of the rear gasket into the square pocket at the rear of the heatsink.

6. Attach the Hex nut to the bottom of the heatsink using a 5/16" nut driver and torque to 5 in-lbs.

7. Snap the PA shield cover into place on the PA shield frame, making sure not to pinch the rear gasket.

8. Slide the rubber grommet/speaker downwards onto the posts on the heatsink with the word TOP facing up.

CAUTION
The speaker cable should be routed in front of the 10-position black header on the main board to prevent the housing's rear hook from dislodging and damaging the speaker connector when replacing the housing (Figure 1-3).

9. Connect the speaker connector into the 2-pin jack on the main board.

Replace Front Panel Display Board

1. Insert the display board into the slide rails by gently tilting the board slightly forward and gently pushiing down until fully seated.

NOTE
Check that the tab on the main board is locked into the slot on the display board.

2. Connect the flex connector cable to the black header on the main board.

Replace Housing Cover

1. Insert the keypad into the housing and press as shown in Figure 1-4. Check to see that all five buttons on the keypad are secured and protruding properly through the housing.

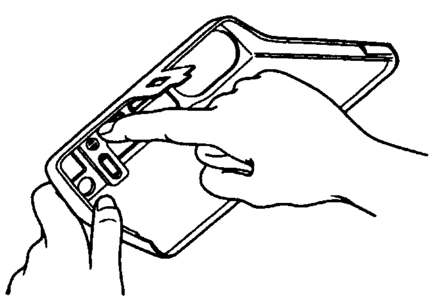


Figure 1-4. Insert Keypad

2. With the radio on a flat surface, place the housing approximately halfway on the heatsink guide rails (Figure 1-5).

3. Using both hands, press down on either side of the housing to assure that the heatsink and housing rails are aligned (Figure 1-5).

NOTE
Do not press on the keypad while sliding the housing onto the heatsink.

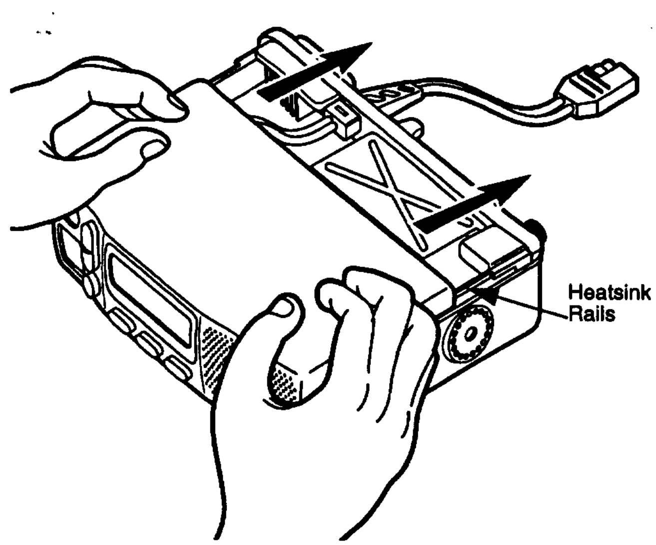


Figure 1-5. Align Housing Cover to Heatsink Rails

4. Slide the housing forward onto the heatsink rails, using both hands, Make sure that the power cord and the rear gasket clear the housingwhen the housing is flush with the rear of the heatsink.

5. Firmly press the housing cover and the heatsink together until the cover latch snaps into place (refer to Figure 1-6).

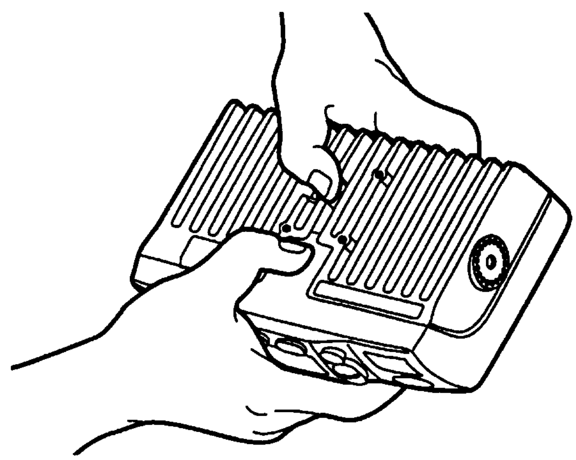


Figure 1-6. Lock Housing Cover into Place

NOTE
Verify that the outside corners of the gasket are properly inserted and aligned with the corners of the housing.

6. Insert the volume control knob by twisting the "D" shaft of the knob onto the volume control shaft while pushing inward.

Install an Advantage™ Board into the AdvantagePort™

The M1225 radio has been designed with an AdvantagePort interface that allows compatible Advantage Boards to be field installed.

IMPORTANT
Before disassembling and reassembling the radio, wear a conducting wrist strap to prevent damage to any component on the main board from electrostatic discharge.

Disassemble Radio

1. Refer to the "Remove Cover Housing" segment of this chapter to remove the cover housing.
2. Remove the three mounting screws from main board using a T10 Torx driver (Figure 1-7).

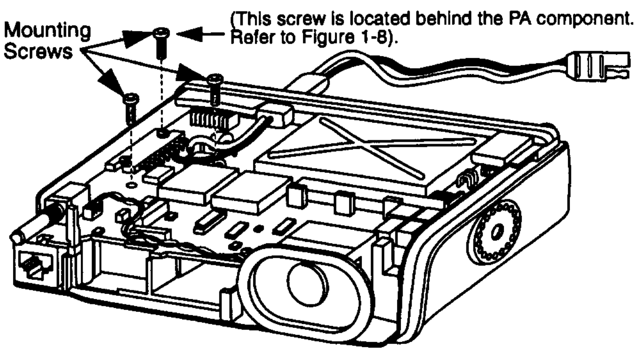


Figure 1-7. Location of Mounting Screws

Insert Advantage Board

1. Insert the three standoff screws into the main board using a 5mm nut driver and torque at 4.5-5.5 in.-lbs.

CAUTION
Avoid excessive force when opening or closing the cover flaps of the 16-pin connectors on both the option and main boards. Damage to the connector's could result!

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2. Locate the 16-pin connector on the Advantage Board and gently lift the cover flap.
3. Locate the 16-pin connector on the main board and gently lift the cover flap.
4. With the component side of the option board facing up, insert and properly align the folded end (blue side up) of the flex connector cable into the 16-pin connector on the Advantage Board.
5. While holding the flex connector cable in place, gently close the cover flap.
6. Insert and properly align the other end (blue side up) of the flex connector cable into the 16-pin connector on the main board
7. While holding the flex connector cable in place, gently close the cover flap.
8. Align the power cables over the main board so they lay flat.
9. With the component side of the option board facing down, position the holes of the Advantage Board over the standoff screws on the main board (Figure 1-8).

NOTE
Make sure that the flex connector cable of the front panel display board is underneath the Advantage Board.

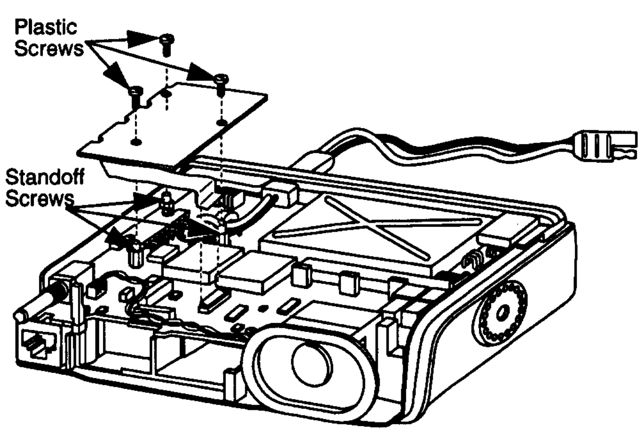


Figure 1-8. Position of Advantage Board

10. Insert the three plastic screws into the Advantage Board using a straight edge screwdriver and torque at 0.7-0.9 in.-lbs.
11. Refer to the "Replace Housing Cover" segment of this chapter to reassemble the housing cover.

Section 2
Theory of Operation

Overview

This section provides detailed theory of operation for the components of the M1225 mobile radio.

Receiver Circuitry

VHF Receiver Front End

The received signal applied to the radio's antenna input connector is routed through the harmonic filter and PIN diode antenna switch. In the receive mode, PIN diodes CR2450 and CR2451 are both off, allowing the signal to pass unattenuated to the receiver front end filter. The insertion loss of the harmonic filter/ antenna switch is less than 1 dB. The harmonic filter provides 19 dB attenuation for image protection at 240 MHz, with increased attenuation at higher frequencies.

The signal is routed to a fixed-tuned 4 pole capacitive-coupled resonator filter having a 3 dB bandwidth of 50 MHz and a 1 dB bandwidth of 45 MHz centered at 162 MHz. Insertion loss is 1.7 dB. Attenuation for image protection is 42 dB at 240 MHz, with increasing attenuation at higher frequencies.

The output of the filter is matched to the base of RF amplifier Q1, which provides 19 dB of gain and has a noise figure of 3 dB. Current source Q2 is used to maintain the collector current of Q1 constant at 30 mA. Transistors Q1 and Q2 are supplied from the 5R source. This source is switched by transistor Q412 which is controlled by U401-54. 5R is only present in the receive mode. This reduces dissipation in Q1 during transmit. Diode CR1 clamps excessive input signals, protecting Q1.

The output of Q1 is applied to a fixed-tuned 3-pole series- coupled resonator filter having a 3 dB bandwidth of 60 MHz and a 1 dB bandwidth of 45 MHz centered at 162 MHz. Insertion loss is 1.3 dB. Attenuation for image protection is 35 dB at 240 MHz, with increasing attenuation at higher frequencies.

A pin diode attenuator is located between the 3-pole filter and the first mixer. The bias current through this diode is switched by dual-composite transistor switch U2. In the Distance mode, U2 is turned on by a logic high at U2-4 from U401-57. CR2 is forward-biased which bypasses R11, and no loss is introduced. In the Local mode, U2 and CR2 are off (U401-57 is low), inserting 10 dB of attenuation due to R11. Because the attenuator is located after the RF amplifier, receiver sensitivity is reduced only by 5 dB, while the overall third order input intercept is raised by 15 dB. Thus, the Local mode significantly reduces the susceptibility to IM-related interference.

The first mixer, U1, is a passive, double-balanced type. This mixer provides all of the necessary rejection of the half-IF spurious response, since the improvement due to filter selectivity is negligible at 150 MHz. High-side injection at +6 dBm is delivered to the first mixer from the injection buffer, Q271, in the VCO/buffer circuit.

The mixer output is connected to a diplexer network which matches its output to the first two pole crystal filter, Y51A, at the IF frequency of 44.85 MHz, and terminates it in a 51 ohm resistor, R51, at all other frequencies.

UHF Receiver Front End

The received signal applied to the radio's antenna input connector is routed through the harmonic filter and PIN diode antenna switch. In the receive mode, PIN diodes CR2650 and CR2651 are both off, allowing the signal to pass unattenuated to the receiver front end filter. The insertion loss of the harmonic filter/ antenna switch is less than 1 dB.

The signal is routed to a fixed-tuned 3 pole shunt resonator filter having a 3 dB bandwidth of 65 MHz and a 1 dB bandwidth of 40 MHz centered at 462 MHz. Insertion loss is 2.0 dB. Attenuation for image protection is 33 dB at 385 MHz, with increasing attenuation at lower frequencies.

The output of the filter is matched to the base of RF amplifier Q1, which provides 17 dB of gain and has a noise figure of 3 dB. Current source Q2 is used to maintain the collector current of Q1 constant at 30 mA. Transistors Q1 and Q2 are supplied from the 5R source. This source is switched by transistor Q412 which is controlled by U401-54. 5R is only present in the receive mode. This reduces dissipation in Q1 during transmit. Diode CR1 clamps excessive input signals, protecting Q1.

The output of Q1 is applied to a fixed-tuned 4 pole shunt resonator filter having a 3 dB bandwidth of 58 MHz and a 1 dB bandwidth of 40 MHz centered at 462 MHz. Insertion loss is 2.8 dB. Attenuation for image protection is 43 dB at 385 MHz, with increasing attenuation at lower frequencies.

A pin diode attenuator is located between the 4 pole filter and the first mixer. The bias current through this diode is switched by dual-composite transistor switch U2. In the Distance mode, U2 is turned on by a logic high at U2-4 from U401-57. CR2 is forward- biased which bypasses R11, and no loss is introduced. In the Local mode, U2 and CR2 are off (U401-57 is low), inserting 10 dB of attenuation due to R11. Because the attenuator is located after the RF amplifier, receiver sensitivity is reduced only by 5 dB, while the overall third order input intercept is raised by 15 dB. Thus, the Local mode significantly reduces the susceptibility to IM-related interference.

The first mixer, U1, is a passive, double-balanced type. This mixer provides all of the necessary rejection of the half-IF spurious response, since the improvement due to filter selectivity is negligible at 474 MHz. Low-side injection at +6 dBm is delivered to the first mixer from the injection buffer, Q271, in the VCO/buffer circuit.

The mixer output is connected to a diplexer network which matches its output to the first two pole crystal filter, Y51A, at the IF frequency of 44.85 MHz, and terminates it in a 51 ohm resistor, R51, at all other frequencies.

Receiver Back End

Q51 amplifies the IF signal from Y51A by approximately 20 dB. The output of Q51 is matched to a second two pole crystal filter, Y51B. The overall 3 dB bandwidth of the crystal filters is 17 kHz. The signal from Y51B is applied to the input of the receiver system IC U51-13. Diode CR51 prevents overload of the second mixer in the receiver system IC.

Q52 is controlled by crystal Y52 which provides the low side injection second local oscillator signal applied to U51-12. The filtered and amplified 44.85 MHz first IF signal mixes with the second local oscillator signal at 44.395 MHz to produce a second IF signal at 455 kHz. The second IF signal is then filtered by switchable ceramic filter FL51 or FL53, amplified, then filtered by switchable ceramic filter FL52 or FL54 and applied to the audio detector. U401-53 controls the bandwidth select switch, Q53, to switch the narrower bandwidth ceramic filters FL51 and FL52 for 12.5 kHz channel spacing or the wider ceramic filters FL53 and FL54 for 20/25/30 kHz channel spacing.

The audio detector is a phase-locked loop type. The free-running oscillator frequency is determined by capacitor C61. Detected audio from U51-31 is routed via noise-peak limiting stage U552 to Rx IN and PL In ports on the audio filter IC (AFIC) U401 (pins 14 and 15 respectively), and also via CMOS switch U553B to op-amp U551B, where output is routed to the accessory connector J3-11 (see "Low-Level Rx Audio").

U51 also contains the carrier-squelch circuitry. When an on-channel signal is present, the amount of high-frequency audio noise, at the detector, is reduced. This change in noise level is sensed to indicate the presence of an on-channel signal. The bandwidth of the sampled noise is determined by C64, C65, R59, R60, and R71 switched by Q54. U401-53 controls Q54 for 12.5 kHz or 20/25/30 kHz channel spacing operation. Squelch sensitivity is adjusted electronically by an attenuator in U402. Squelch noise is routed from U51-26 to U402- 23, and the adjusted noise level is returned from U402-26 back to U51-23. This noise level is detected in U51 and compared to a preset threshold. Noise levels greater than a preset threshold, indicating weak or no signal present, cause U51-18 to go low. This is routed to microcomputer port PC5 (U401-55). When the noise level decreases below the threshold, due to on-channel quieting, U51-18 and therefore U401-55 go high. This indicates an on-channel signal is present, and the microcomputer unmutes the audio path.

Components R57, C68 and C69 determine squelch time constants as a function of the charging currents supplied by U51. These charging currents vary from weak to strong signal conditions, providing a variable squelch closing time-constant. For weak signals the time constant is long to minimize "chattering" or rapid muting and unmuting of the audio. For strong signals, where the carrier-absent to carrier-present conditions are substantial, the closing time-constant is shortened to minimize the length of the "squelch-tail".

Frequency Generation System

The frequency generation system utilizes two IC's, the Fractional-N Synthesizer (U201) and the VCO/Buffer (U251). Designed to maximize compatibility, the two IC's provide many functions which would normally require additional circuitry.

The frequency generation circuitry is supplied from the analog 5 V supply regulated by U405. The synthesizer IC further filters this voltage (SUPFOUT, U201-18, 4.65 Vdc) and supplies it to the VCO/Buffer IC.

The synthesizer also interfaces with the logic and AFIC circuitry. Synthesizer programming is accomplished through the SR DATA (U201-5), SR CLOCK (U201-6), and SYN LE (U201-7) lines by microcomputer U401. A serial stream of 98 bits is sent whenever the synthesizer is programmed. Synthesizer lock is indicated by a logic high at LOCK DET pin U201-2, and a logic low indicates out- of-lock.

In the transmit mode, modulation from the attenuators in the AFIC (U402-27 and 28) is resistively summed and applied to U201-8. The audio is digitized within U201 and applied to the loop divider to provide the low-port modulation. The audio is also routed through an internal attenuator for balancing of the high and low port modulation, before being applied to the VCO from U201-28.

The AFIC employs switched-capacitor filters which require an external 2.1 MHz clock signal. This clock is generated in U201 by dividing the 16.8 MHz reference oscillator. The signal, at U201- 11, is filtered, attenuated, and applied to U402-43 at a level of approximately 2 Vp-p.

Synthesizer

The Fractional-N synthesizer uses a 16.8 MHz crystal (Y201) to provide the reference frequency for the system. External components C201-3, R201-2, and CR201 are also part of the temperature-compensated oscillator circuit. The dc voltage applied to varactor CR201 is determined by a temperature compensation algorithm within U201, and is specific to each crystal Y201 based on a unique code assigned to the crystal.

The divided frequencies of the reference oscillator and the VCO signal (as applied to U201-20) are compared to generate the necessary correction voltage, or steering line voltage, which maintains the proper VCO frequency. The steering line voltage from U201-29 is filtered and applied to varactors CR241 and CR251 to control the frequencies of the receive and transmit VCOs respectively. To achieve fast lock time, an internal adaptive charge pump provides higher momentary current capability at U201- 31 than in the normal steady-state mode. The normal and adapt charge pumps receive their dc supply from a voltage-multiplier circuit which includes CR211, CR212 and associated capacitors C210-C216. By combining two 5 V square waves which are 180 degrees out-of-phase and adding this to the regulated 5 V supply, a source of approximately 12.6 Vdc is available at U201-32. The current for the normal mode charge pumps is set by R242. The pre-scaler for the loop is internal to U201 with the value determined by the frequency band of operation.

VCO

The VCO (U251) used in conjunction with the Fractional-N synthesizer (U201) generates an RF signal for both receive and transmit modes. The TRB line (U251-5) determines which oscillator and buffer is enabled, as described below. A sample of the RF signal from the enabled oscillator is routed from U251-23 to the prescaler input U201-20 via a matching network. After frequency comparison with the reference in the synthesizer, a resultant control voltage is applied to the varactors CR241 and CR251. This voltage, when locked, is between 3 and 10 V depending on VCO frequency.

In the receive mode, U251-5 is low, enabling the receive VCO and buffer in U251. The RF output signal at U251-2 is further amplified by Q271, low-pass filtered, and matched to the 50 ohm injection port of first mixer U1 at a level of +6 dBm.

During transmit, U251-5 is high, activating the transmit VCO and buffer. The RF output signal at U251-4 is low-pass filtered and matched into Q281 for further amplification before being applied to the RF power amplifier. A resistive attenuator (R284 through R286) isolates the VCO and buffer from impedance variations presented by the power amplifier for improved stability. The power output presented to the first stage (Q2610) of the RF power amplifier is +13 dBm.

Transmit and Receive Audio Circuitry

The majority of Rx and Tx audio processing is performed by U402, the Audio Filter IC (AFIC), which provides the following functions:

- Tone/Digital PL encoding and decoding
- PL rejection filter in Rx audio path
- Tx pre-emphasis amplifier
- Tx audio limiter
- Post-limiter (splatter) filter
- Tx deviation adjust digitally-controlled attenuators
- Programmable microphone gain attenuator
- Carrier squelch digitally-controlled attenuator
- Microcomputer output port expansion
- 2.5 Vdc reference source

The parameters of U402 which are programmable are selected by the microcomputer via the SR CLOCK (U402-39), SR DATA (U402-38) and chip enable (U402-41) lines.

Rx Audio Path

Low-Level Rx Audio

Detected audio from the IFIC U51-31 is routed via C553 to the switchable-gain limiter stage U552. The gain of limiter stage U552 is changed for 12.5 kHz or 25 kHz channels so that its output limits at slightly greater than full system deviation in either case. This limits the loudness of noise relative to voice during fading, weak signal conditions and squelch tails. Output is taken from this stage at two places. Pin 4, which is the (-) input, serves as an output which feeds AFIC ports Rx IN (pin 14) and PL IN (pin 15) via C551. The feedback around the op amp stage maintains the signal at U552-4 exactly equal to the signal applied to the (+) input, but the signal at U554-4 benefits from the selectable noise limiting threshold. Gain adjustments in the receive audio path for 12.5 or 25 kHz channels are then made in the AFIC. A second output from the limiter stage is taken at pin 1 and is affected by the gain change of U552 so that the level is a constant 840 mV rms at 60% deviation for either 12.5 or 25 kHz channels. This level is attenuated 12 dB by R573, R579 and R580 and routed to the Detector Audio Send pin of the AdvantagePort™ connector (J13-16).

Detected audio from the IFIC U51-31 is also routed via a switchable-gain path (R577, R578 and U554A) to analog switch U553B (see "Accessory Connector Rx Audio Path").

The audio applied to the AFIC at U402-14 (Rx IN) is sharply high- pass filtered to remove all PL and DPL tones below 300 Hz. Audio is then routed through a digitally controlled attenuator which is set to approximately 6 dB attenuation. This attenuation is non-adjustable and maintains the output at U402-31 (Rx OUT) at a fixed and defined level of 450 mV rms for 60% deviation, since this level is applied to the AdvantagePort connector (J13-6). Receive volume adjustment is accomplished at a later point using the volume control R554. The internal de-emphasis characteristic within U402 is enabled, with the result that audio at U402-31 is de-emphasized but unmuted.

This audio signal is processed by the option board if present, or passed through resistor R551 if no option board is installed, and then fed to the expander portion of compander IC U555. The operation of the compander is described below. The output from the compander IC is routed through mute gate U554D, amplified by U551A and fed to the volume control, and also to handset audio buffer U551D (see "Handset Audio Path") and analog switch U553B (see "Accessory Connector Rx Audio Path").

Audio Power Amplifier

Audio from the wiper of the volume control is amplified by the audio power amplifier IC U501. This is a bridge amplifier delivering 7.8 V rms between pins 4 and 6 without distortion. This is sufficient to develop 7.5 watts of audio power into an external 8 ohm load, or approximately 4 watts of audio power into an internal 16 ohm speaker (under this condition, undistorted audio output voltage swing exceeds 8 volts rms). The audio power amplifier is muted whenever speaker audio is not required, to reduce current drain and eliminate noise in the speaker. The audio amp is muted when U501-8 is low. This occurs if Q501 is saturated (U402-9 high) or when the radio is turned off. The current drain into supply pin U501-7 is negligible when U501-8 is low.

Because the power amplifier is a bridge-type, neither speaker terminal is grounded. Care should be taken that any test equipment used to measure the speaker audio voltage does not ground either speaker output terminal, otherwise damage to the audio power amplifier IC may result. If the test equipment input is not isolated from ground, voltage measurements may be made from one of the speaker output terminals (J3-1 or J3-16) to ground, in which case the voltage indicated will be one half of the voltage applied to the speaker or load resistor. When an 8-ohm load resistor is used, it should be connected across pins 1 and 16 of J13, never to ground.

Handset Audio Path

Rx audio from U551A-1 is amplified by op amp U551D and applied to the microphone connector J5-8 for use with a telephone-type handset. This audio is de-emphasized, and muted by U554D. It is also affected by any receive audio processing circuits on the option board, if installed, and by the compander, if enabled. When the radio has been programmed for handset operation, the audio power amplifier is muted whenever the handset is off- hook by a logic high from U402-9. This silences the speaker when the handset is in use.

Accessory Connector Rx Audio Path

Rx audio is amplified by stage U551B and is available at the accessory connector pin 11. This audio may be one of two types, depending on the RSS programming of analog switch U553B.

If U553B-10 is programmed high, the audio fed to U551B comes from the receiver's detector audio via a switchable-gain path using R577, R578 and U554A. In this case, audio at the accessory connector (J3-11) is "flat" (non-de-emphasized) and unmuted.

If U553B-10 is programmed low, the audio fed to U551B comes from U551A. Audio at J3-11 is de-emphasized and muted. This path will also be affected by any receive audio processing circuits on the option board, if installed, and by the compander, if enabled.

PL Decoder

Detected Rx Audio which has been limited by stage U552 is applied to the AFIC PL IN port (U402-15), where it first passes through the Tone PL filter or Digital PL filter, depending on the PL option selected for the current operating mode. Filtered PL is then coupled to the PL detector circuit, with detected output at U402-35. The detected PL signal is coupled from U402-35 to microcomputer port PA1 (U401- 15) where algorithms perform the final PL decoding. Data for the tone PL frequency or Digital PL code for each mode is programmed through the Radio Service Software.

AdvantagePort™ Internal Option Board Rx Audio Path

De-emphasized, unmuted audio is available at J13-6 for use by an internally installed option board. If this audio is to be processed and returned to the radio's receive audio path, the processed audio will be returned from a low-impedance source on the option board to J13- 8. The unprocessed audio through R551 is shunted due to the low source impedance of the option board at J13-8. Since the gain of the AFIC is different for 12.5 or 25 kHz channels, the RX audio level at J13-6 is always 450 mV at 1 kHz and 60% deviation, regardless of the channel spacing. Similarly, audio returned to J13-8 from the option board should be supplied at a level of 130 mV rms at 60% deviation, regardless of the channel spacing.

Non-de-emphasized, unmuted audio is available at J13-16. Options requiring non-de-emphasized audio may use this, or may re-pre- emphasize the audio at J13-6, depending on the design of the option board. Because the gain of stage U552 is different for 12.5 or 25 kHz channels, the RX audio level at J13-16 is always 210 mV at 60% deviation, regardless of the channel spacing.

Noise Squelch Attenuator

The AFIC contains a 16 step programmable digital squelch attenuator whose input is U402-23 and output is U402-26. Noise squelch sensitivity is set using RSS, with open squelch at step 0 and maximum (tight) squelch at step 15.

Tx Audio Path

Voice Path via Front Panel

Microphone audio from the front panel mic jack J5-5 is attenuated from 80 mV rms (for 60% deviation at 1 kHz) to 65 mV by R658 and R659. When mic PTT is sensed from J5-6, CMOS gate U554C is enabled by a logic low at U402-5, which is inverted by Q651 to provide a logic high at U554C-6.

This audio is fed to the compander IC where it is amplified from 65 mV to 100 mV by an op amp gain stage (pins 7 and 6) and then applied to the compressor portion of the compander (pin 3). The output (pin 2) is attenuated back to the original 65 mV rms level by another op amp stage (pins 9 and 10) and applied as a low- impedance source to the Tx Audio Send pin of the AdvantagePort connector (J13-10).

Voice Path via Accessory Connector

Microphone audio from an accessory such as a desk set applied to External Mic Audio input J3-2 is attenuated from 80 mV rms (for 60% deviation at 1 kHz) to 65 mV by R666 and R665. When External Mic PTT is sensed at J3-3 (or from any programmable input to which Ext Mic PTT has been assigned), CMOS gate U554B is enabled by a logic high at U401-47.

This audio is fed to the compander IC and processed as described above for the Voice Path via Front Panel.

AdvantagePort™ Internal Option Board Tx Audio Path

Non-pre-emphasized microphone audio is available at J13-10 for use by an internally installed option board. If this audio is to be processed and returned to the radio's transmit audio path, the processed audio will be returned from a low-impedance source on the option board to J13-12 (Tx Audio Return). The unprocessed audio through R654 is shunted due to the low source impedance of the option board at J13-12. Since deviation is adjusted appropriately by the AFIC for 12.5 or 25 kHz channels, the TX audio level at J13-10 and J13-12 is always 65 mV for 60% deviation at 1 kHz, regardless of the channel spacing.

Some option boards must be able to modulate the transmitter with very low frequency data. The Post-Limiter Flat Tx Audio Return pin (J13-2) is used for this application. Audio from this pin is routed to the AUX Tx IN pin on the AFIC (U402-20) via summing op amp stage U551C. A level of 150 mV rms will produce 60% deviation regardless of channel spacing. This path bypasses the limiter stage in the AFIC, therefore the option board must provide the necessary amplitude limiting of this signal to prevent overdeviation. The AUX Tx IN path of the AFIC must be enabled via software control for this path to be active.

Pre-emphasis of Microphone Audio Signals

Pre-emphasis of the front panel or accessory microphone audio signal occurs after the AdvantagePort option board processing has occurred. Series capacitor C651 provides the pre-emphasis characteristic of audio applied to the Tx IN pin of the AFIC (U402-17). This pin is the summing junction of an inverting op- amp gain stage within U402. Audio processing, including limiting, splatter filtering, and level adjustment are performed within U402. The outputs of the two programmable deviation-adjustment attenuators (U402-27 and 28) are resistively summed and applied to the VCO modulation input of the frequency generation system.

Flat (Non-Pre-Emphasized) Tx Audio Path via Accessory Connector

Audio applied at J3-5 may be routed to the transmitter either before the limiter (PRE-LIM) or after (POST-LIM). This is programmed using RSS. The path is controlled by CMOS gate U553C, as controlled by U402-8 (low for PRE-LIM, high for POST-LIM). When the POST-LIM path is chosen, audio is routed via R671 and op amp U551C to the AUX TX INPUT (U402-20), therefore this input of the AFIC must be enabled via software control whenever an accessory connector PTT is sensed at J3-3 (or from any programmable input to which Accessory PTT has been assigned).

If the PRE-LIM path is chosen, audio is coupled by C655 and R670 to the summing input of an op amp within U402 (pin 17). Because R670 is significantly larger than R671, R669 provides a charging path for C655 when the PRE-LIM route is selected which is equivalent to the charging path via R671 in the POST-LIM path.

Audio present at J3-5 is muted during transmitter key-up until the frequency synthesizer has settled and locked on-frequency. This prevents unintentional frequency offset due to the presence of modulation while PTT is keyed. Muting occurs when U401-9 provides a low to U553A-11. While muted, R672 maintains the same dc bias on C655 to prevent switching transients.

Tx Data Encoder (D/A Converter)

Data such as MDC or DTMF signalling can be encoded into the TX audio path by generating the waveform at ports PA3, PA4 and PA5 of U401 (pins 13, 12 and 11 respectively). These outputs are resistively summed and weighted to allow either square waves or pseudo-sinewaves to be encoded. Op amp U551C provides active summing and outputs the signal to the AUX Tx IN port of the AFIC (U402-20). Connection is also made to the AUX Rx IN port (U402- 13) to allow true sidetones to be heard, for example when DTMF tones are encoded. The AUX Tx IN path of the AFIC must be enabled via software control when the data encoder is operating.

The data encoder circuit may not be utilized in all models.

Compander Operation

The compander circuit of U555 is used to improve the signal-to- noise ratio of the voice communications path. This is accomplished by compressing the microphone signal during transmit by a ratio of 2:1 so that a 60 dB range of level changes at the microphone are reduced to only a 30 dB change before being transmitted. A complimentary expander circuit in the receiver audio path restores the 30 dB range of the received signal to its original 60 dB range before being applied to the speaker. Any noise occurring in the over-the-air transmission which is more than 30 dB below full deviation is reduced to greater than 60 dB below the peak voice level at the speaker, making such noise essentially inaudible.

The effectiveness of the compander system requires that both the transmitter and receiver utilize companding. It is possible to program the compander off on a per-channel basis using RSS, for use in systems with other radios that do not have the compander feature. The compander is active when U555-8 is low, and is bypassed when U555-8 is high. When in the bypass mode, the gain of the compressor (pin 3 in, pin 2 out) and expander (pin 14 in, pin 15 out) circuits is unity.

Q553 and C581 keep the compander turned off for approximately one second when the radio is turned on, to allow the compander circuits sufficient time to stabilize. At turn-on, U401-30 pulses low, which turns on Q553 and quickly charges C581 to 5 V, bypassing the compander. If the compander should be on, U401-30 stays high, and C581 discharges due to the internal resistance of U555-8. After one second, the voltage at U555-8 is low enough to enable the compander. If the compander should be off, U401-30 remains low, keeping Q553 on and U555-8 high.

Q554 and Q555 are used to increase the receive audio path gain by approximately 4 dB whenever the compander is turned on. This maintains the same subjective audio level for both compander and non-compander channels.

Public Address Operation

When the public address switch box and amplified speaker(s) accessories are used, and the radio has been programmed by RSS for public address, operation is as follows:

Turning on either the INT PA or EXT PA switches on the public address switch box provides a low at pin 14 of accessory connector J3. This enables public address operation of the radio. In this condition, radio receiver operation is unaffected, but keying of the transmitter is inhibited. If a MIC PTT is sensed from microphone jack J5-6, both the INT MIC ENABLE and EXT MIC ENABLE lines go high (U402-5 is low and U401-47 is high). This turns on both mic audio gates U554C and U554B, and allows audio from the microphone jack J5-5 to be routed directly to accessory connector J3-2. Mic audio from J3-2 is then routed to the selected public address amplified speakers by the public address switch box.

To prevent loading of the mic audio signal and loss of low frequency response, U651 senses that both INT MIC and EXT MIC enable lines are high and provides a low at its output, turning off U652 and removing the loading of R665 from the audio path. At all other times, U652 is on to provide microphone bias voltage to the external mic input via R665.

Transmitter Circuitry

VHF 40 Watt Transmitter RF Power Amplifier

The 40 watt VHF power amplifier is designed to cover the range of 150-174 MHz and has four stages. The first stage, Q2410, operates in Class A from the 8T source. It provides 13 dB of gain and an output of 400 mW.

The second stage, Q2420, has a nominal gain of 9.4 dB and power output of up to 3.5 watts. The output of this stage is adjusted by the controlled B+ voltage which supplies its collector. (VB+ max = 6.55 V).

The third stage, Q2430, operates in Class C with 8.1 dB gain and output power up to 22 watts. Collector voltage is directly from UNSW B+.

The fourth stage, Q2440, is the final RF power amplifier, which operates in Class C, is directly from UNSW B+. It provides up to 65 watts output.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2480 (forward power) and CR2481 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2450 and CR2451. L2452 and C2450, combined with the "on" inductance of CR2451, form a series resonant circuit to lower the shunt impedance presented by CR2451 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2451 and C2453 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitter RF from Q2440 via the directional coupler is routed through CR2450, and via the harmonic filter to the antenna jack. CR2451 conducts, shunting RF power and preventing it from reaching the receiver. L2451 is selected to appear as a 1/4 wave at VHF, so that the low impedance of CR2451 appears as a high impedance at the junction of CR2450 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebychev low pass filter with a 3 dB frequency of approximately 200 MHz and less than 1 dB insertion loss in the passband.

UHF 10-40 Watt Transmitter RF Power Amplifier

The 40 watt UHF power amplifier is designed to cover the range of 450-474 MHz and has four stages. The first stage, Q2610, operates in Class A from the 8T source. It provides 11.8 dB of gain and an output of 300 mW.

The second stage, Q2620, has a nominal gain of 8.2 dB and power output of up to 2 watts. The output of this stage is adjusted by the controlled B+ voltage which supplies its collector.

The third stage, Q2630, operates in Class C with 8.1 dB gain and a power output of up to 13 watts. Collector voltage is directly from UNSW B+.

The fourth stage, Q2640, is the final RF power amplifier, which operates Class C directly from UNSW B+. It provides up to 30 watts output for low power and 50 watts output for high power.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2680 (forward power) and CR2681 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2650 and CR2651. L2652 and C2650, combined with the "on" inductance of CR2651, form a series resonant circuit to lower the shunt impedance presented by CR2651 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2651, C2653, and L2664 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitter RF from Q2640 via the directional coupler is routed through CR2650, and via the harmonic filter to the antenna jack. CR2651 conducts, shunting RF power and preventing it from reaching the receiver. L2651 is selected to appear as a 1/4 wave at UHF, so that the low impedance of CR2651 appears as a high impedance at the junction of CR2650 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebychev low pass filter with a 3 dB frequency of approximately 600 MHz and less than 1 dB insertion loss in the passband.

Power Control Circuit

The power control circuit is a dc-coupled amplifier whose output is the controlled voltage applied to the second stage of the RF power amplifier (Q2420 in VHF or Q2620 in UHF).

The input voltage to U451A-2 is a dc voltage from the directional coupler forward power detector, and is proportional to RF power output. This is compared to a dc voltage applied to U451A-3 which is proportional to the desired output power setting. This voltage is obtained by integrating a series of square wave pulses from port PH1 of the microprocessor (U401-26). The duty cycle of these pulses is varied in proportion to the desired output power setting. Components R458, C467, R457 and C458 integrate the PWM pulses into a smooth dc voltage.

The power control loop varies the output of stage Q2420 or Q2620 as necessary to keep equal voltages at U451A pins 2 and 3, and thus maintains forward power at the adjusted setting.

Under conditions of poor antenna match resulting in high reflected power, the dc voltage at U451A-3 is reduced due to a lowering of the voltage at U451B-7. This is interpreted by the power control circuit as a lowering of the desired output power.

The temperature-sensing circuit protects the PA devices from excessively high temperatures. As the PA temperature increases, the resistance of thermistor R462 decreases. This causes Q453 to conduct, reducing the voltage at the base of Q452. This reduces the conduction of series pass device Q451, lowering the control voltage and therefore the output power.

Over-voltage protection prevents the control voltage from rising so high that the subsequent transmitter stages may be overdriven. Zener diode VR451 conducts when the control voltage exceeds 5.3 V in VHF models or 10.6 V in UHF models. This causes Q453 to conduct, lowering the control voltage as described earlier.

PTT Circuits

The logic system uses a single microcomputer A/D input port PE1 (U401-36) to distinguish between two different types of PTT information. This is done by assigning different voltage levels to the different PTT functions as follows:

0 to 2.1 Vdc (0.6 Vdc typ): Microphone PTT
2.2–3.6 Vdc (2.6 Vdc typ): Accessory PTT
4.75 to 5.0 Vdc (5.0 Vdc typ): Receive Mode

A microphone connected via the front panel jack J5 must present a low of less than approximately 2.0 V dc to be correctly interpreted as MIC PTT and cause the appropriate audio paths to be enabled. Similarly, an accessory whose PTT output is connected to J3-3 must present a low of less than approximately 2.0 V dc to be interpreted as an accessory PTT. This voltage is shifted to the range between 2.2 and 3.6 V by series resistor R432.

Some accessories connected to J3 need to sense microphone PTT by looking for a low at J3-3. Diode CR408 causes J3-3 to be pulled low whenever microphone connector J5-6 is low.

Programmable I/O's

Pins 4, 6, 8, 9, 12, and 14 are programmable I/O's. They are used to control external accessories by the radio, or for control of radio functions by accessories.

Pin 4 is an output only. When U401-21 is high, Q901 and Q902 are on, and pin 4 is pulled high to the battery voltage. This is normally used to turn on a relay for activating the vehicle's horn or lights.

Pin 6 is an input only. Normally, R905 pulls pin 6 high, turning on Q903 and pulling U401-45 low. If pin 6 is pulled low, U401-45 goes high.

Pin 8 is an I/O (input and output). To function as an input, Q905 is turned off by keeping U401-20 low. Then, R907 pulls pin 8 high, turning on Q904 and pulling U401-44 low. If pin 8 is pulled low, U401-44 goes high. To function as an output, Q905 pulls pin 8 low whenever U401-20 is high.

Pin 9 is an input only. Normally, R909 pulls pin 9 high, turning on Q906 and pulling U401-46 low. If pin 9 is pulled low, U401-46 goes high. The emergency switch accessory, if used, is connected here.

Pin 12 is another I/O. To function as an input, Q909 is turned off by keeping U401-19 low. Then, R913 pulls pin 12 high, turning on Q908 and pulling U401-43 low. If pin 12 is pulled low, U401-43 goes high. To function as an output, Q909 pulls pin 12 low whenever U401-19 is high.

Pin 14 is also an I/O. To function as an input, Q911 is turned off by keeping U401-22 low. Then, R915 pulls pin 14 high, turning on Q910 and pulling U401-42 low. If pin 14 is pulled low, U401-42 goes high. To function as an output, Q910 pulls pin 14 low whenever U401-22 is high.

Zener diodes and bypass capacitors on each programmable I/O line prevent damage or abnormal operation due to ESD transients or RF fields.

The extent to which programmable I/O functions are supported may vary with different radio models. RSS allows the functions which are supported to be programmed.

DC Regulation and Distribution

Unswitched B+ supplies operating voltage directly to the RF power amplifier third and fourth stages, the power control series pass device Q451-E, the RAM keep-alive constant voltage supply to U401-62, the audio power amplifier supply pin U501-7 and, via fuse F401, to the on-off switch and external alarm switch transistor Q902-E. All of these circuits draw negligible current when the radio is turned off (less than 15 mA total).

When the on-off switch is "on," battery voltage is applied to 8 volt regulator U406, and via R502 to pin 8 of the audio power amplifier U501 which turns it on unless muted by Q501. The regulated output of U406 is routed to the display board for backlighting, to 8T transistor switch Q414, to U51 pins 16 and 17, to op amp U551 supply pin 4, and to the inputs of the 5 volt regulators U404 (digital) and U405 (analog). Separate analog and digital regulators are used to minimize microcomputer noise from being introduced into sensitive VCO and receiver circuits. The digital 5V regulator includes a reset timer which hold the reset line U404-3 low for a predetermined time after the radio is turned on. Zener diodes on the 8V and digital 5V lines minimize susceptibility to ESD damage.

Ignition control of the radio is accomplished by removing fuse F401. The radio will only be able to turn on if battery voltage from the vehicles ignition switch is applied to accessory connector J3 pin 10. This voltage is routed to the on-off switch.

20-Channel LCD Front Panel Display Board

The 8-character display board contains back lighting LED's, and an LCD that is driven by the LCD driver IC, U1101. When the LCD driver, U1101, is enabled via the CE (Chip Enable) input, the desired display information is then loaded serially via the SR Data line into U1101 from the microprocessor. U1101 also has a clock input that is connected to the main board SR Clock.

The back lighting for the 8-character display board can be toggled between two colors, amber and green per the users choice. This color choice for the LED's is controlled by the microprocessor, which in turn gets its input from either the RSS setup, or one of the pushbuttons if so enabled. Each color of back lighting is produced by 12 pairs of LED's, which are turned on by applying a ground to the cathodes of the 12 pairs of LED's.

To enable the amber LED's, a DC level of 5 V from the microprocessor is applied to the base of Q1108. This 5 V saturates Q1108 which connects a ground to the amber LED cathodes and also the base of Q1107. With the base of Q1107 grounded, the transistor operates in the cutoff mode which leads to the collector having a potential of ~8 V, which is also applied to the cathode of the green LED's.

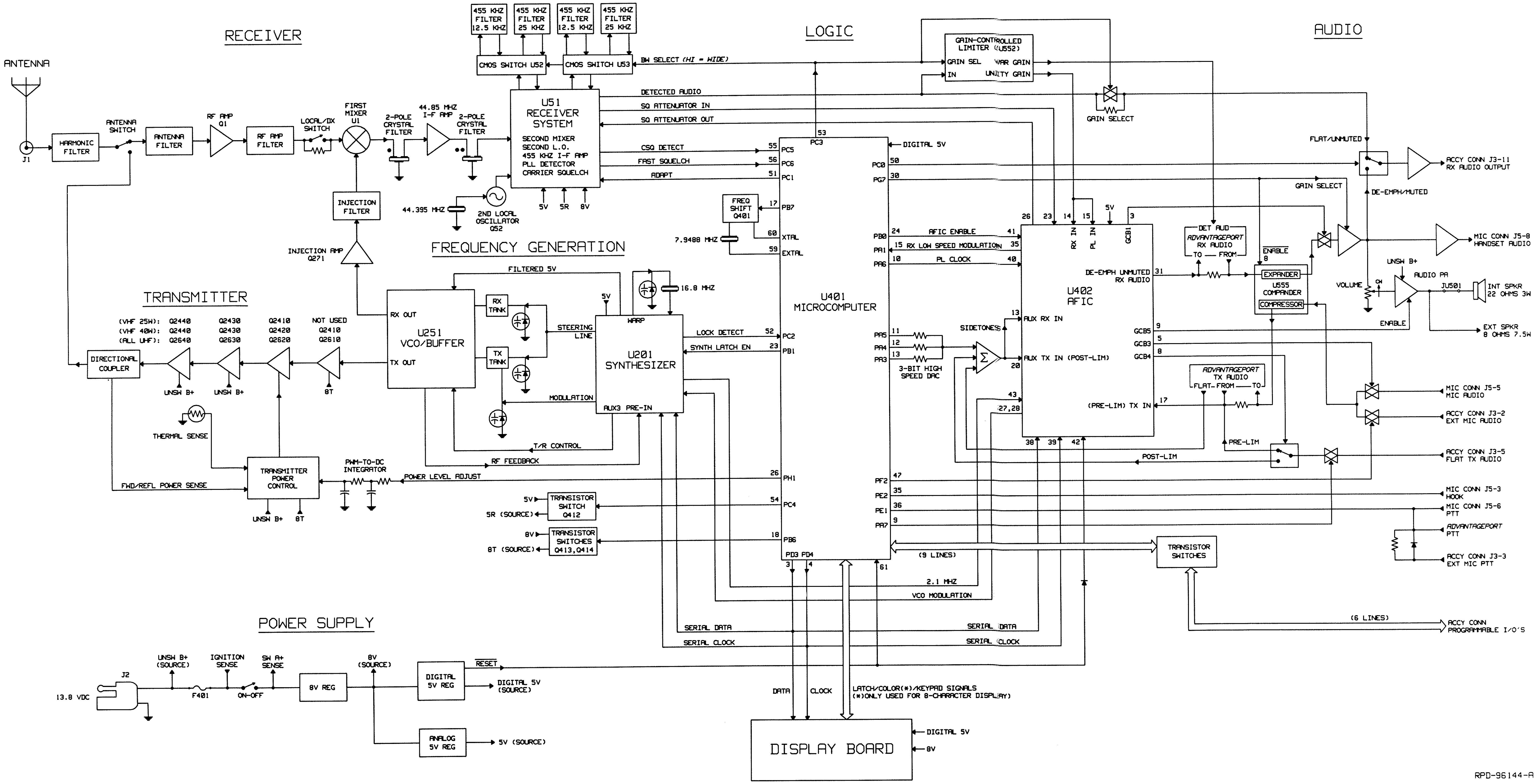
To enable the green LED's, a DC level of 0 V (ground) to the base of Q1108 keeps Q1108 in cut-off mode which leads to the collector of Q1108 having a potential of 8 V. This 8 V potential on the collector of Q1108 is also applied to the base of Q1107 via R1125, thus saturating Q1107 and connecting the green LED's to ground.

The six pushbuttons apply voltage to the bases of six digital transistors, Q1101 through Q1106. The appropriate transistor, in turn, grounds a tap on the series resistor ladders R1117 through R1122, producing a different DC level depending on which button is pressed. These DC levels are interpreted by an A/D input of the microprocessor (U401-37) and the corresponding function is enabled. The transistors ensure that the DC ladder voltage is consistent, although the series resistance of the keypad may vary.

4-Channel LED Front Panel Display Board

The LED display board contains back lighting LEDs for the keypad, channel indicator LEDs; and status indicators for transmit, monitor, and options. The channel and status display information is loaded serially into the shift register, U101. This information is then latched and turns on the LEDs, DS101 - DS105 and DS1012 - DS1014 via the driver transistors, Q1001 - Q1008.

The six pushbuttons apply voltage to the bases of six digital transistors, Q1009 through Q1014. The appropriate transistor, in turn, grounds a tap on the series resistor ladders R1017 through R1022, producing a different DC level depending on which button is pressed. These DC levels are interpreted by an A/D input of the microprocessor (U401-37) and the corresponding function is enabled. The transistors ensure that the DC ladder voltage is consistent, although the series resistance of the keypad may vary.



M1225 Mobile Functional Block Diagram

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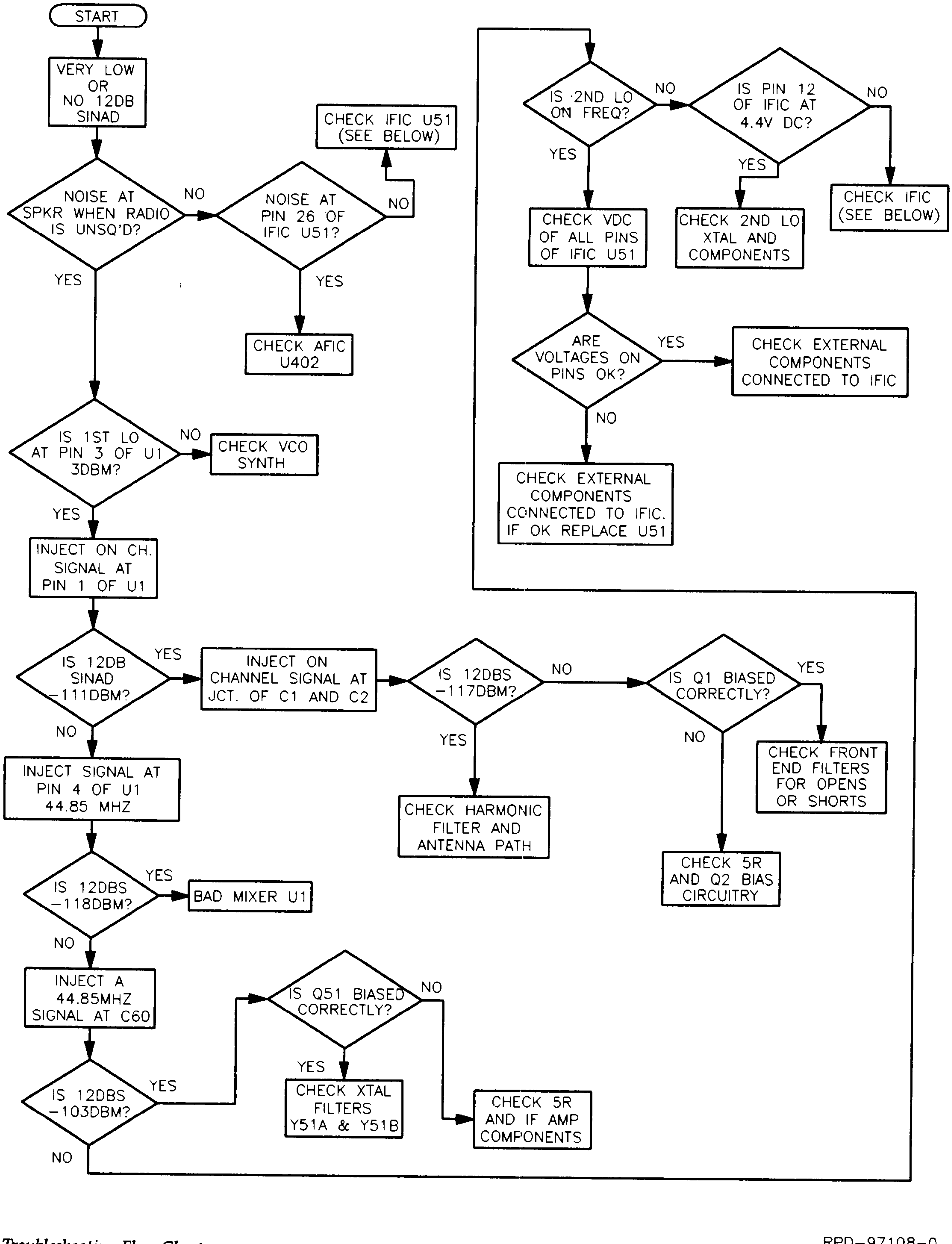
Section 3
Troubleshooting

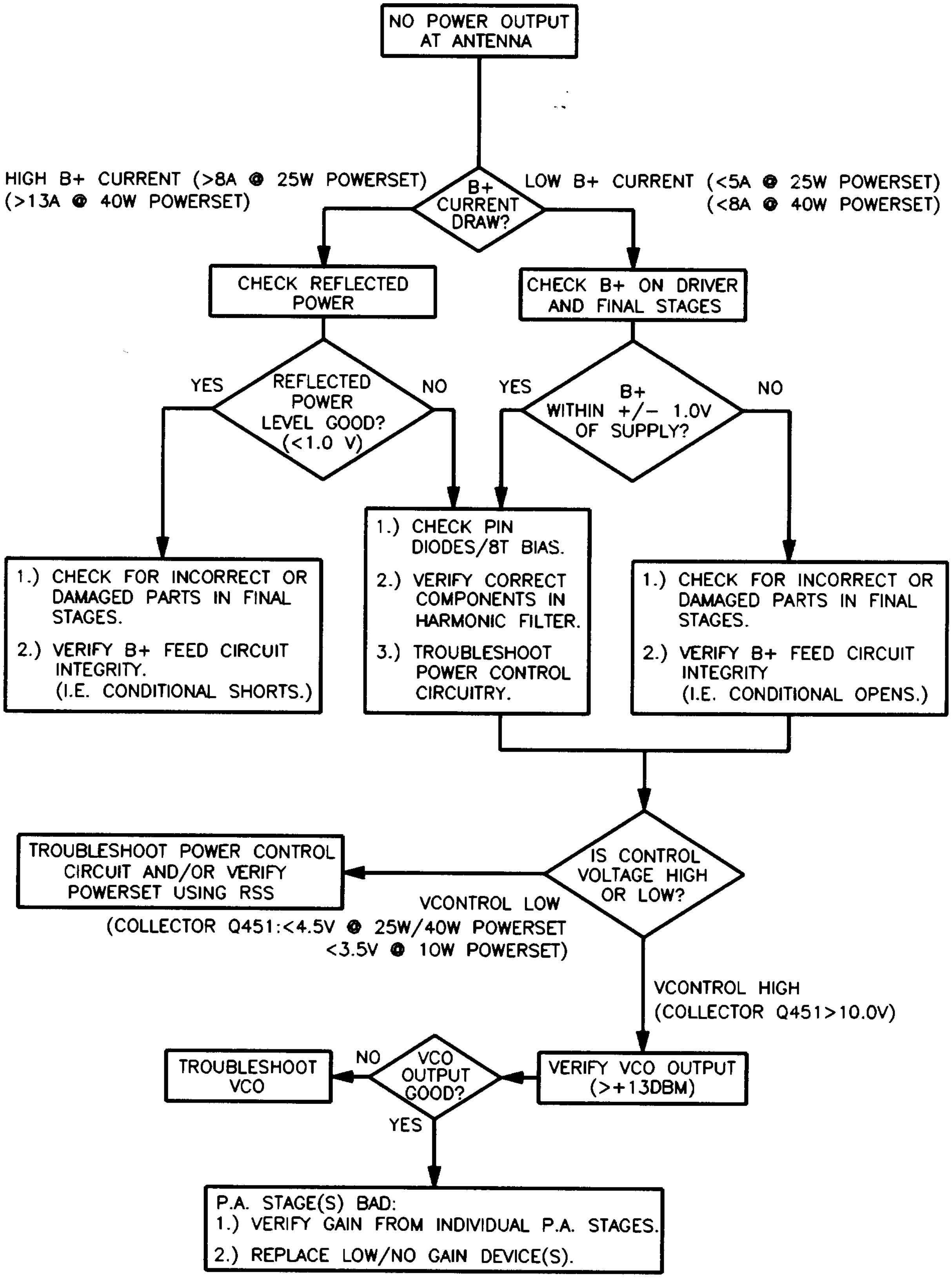
Overview

This section contains 5 troubleshooting tables for the following M1225 components:

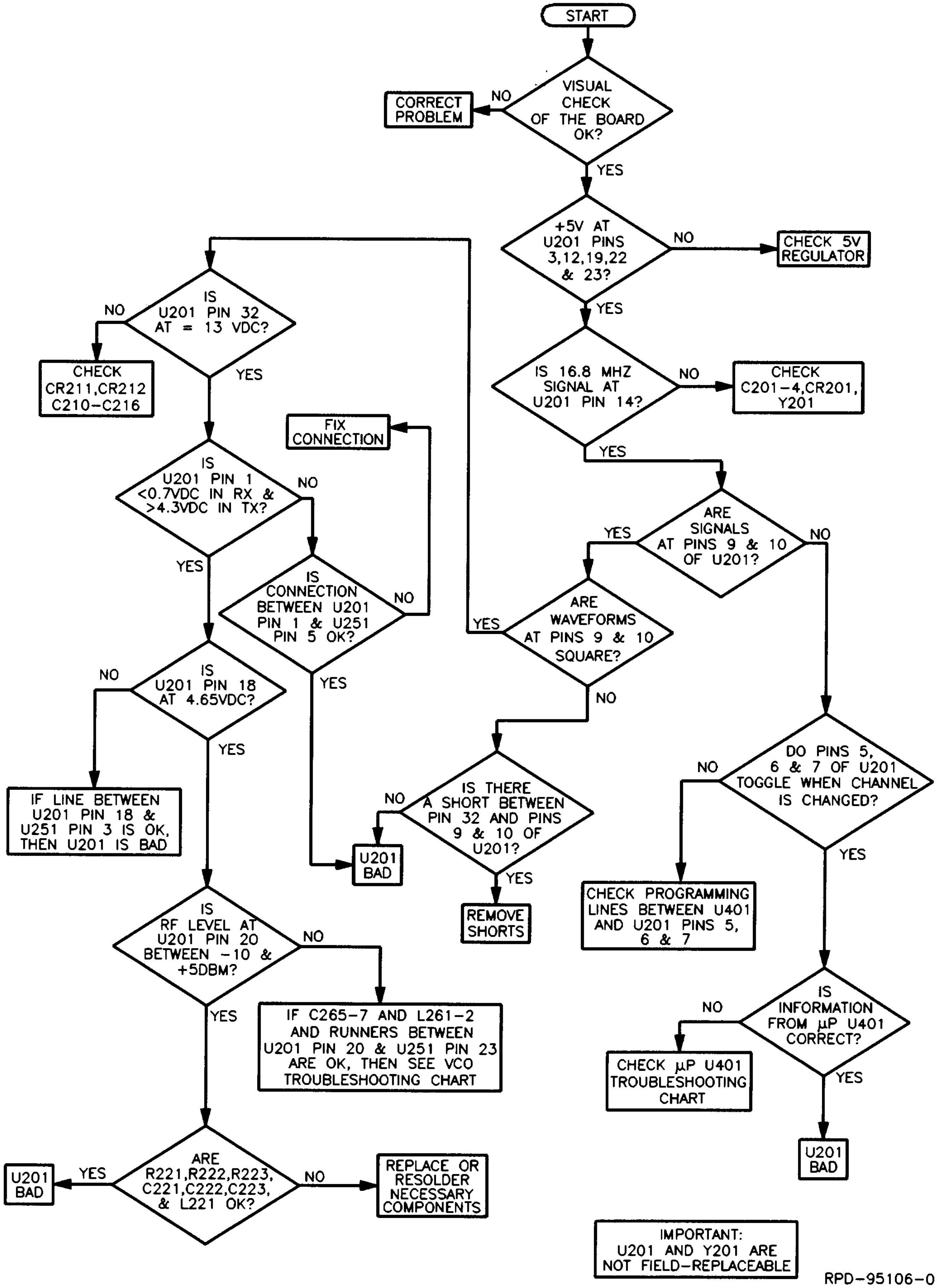
- Receiver (all models)
- Transmitter (all models)
- Synthesizer (all models)
- Voltage Controlled Oscillator (VCO) (all models)
- Microprocessor (all models)



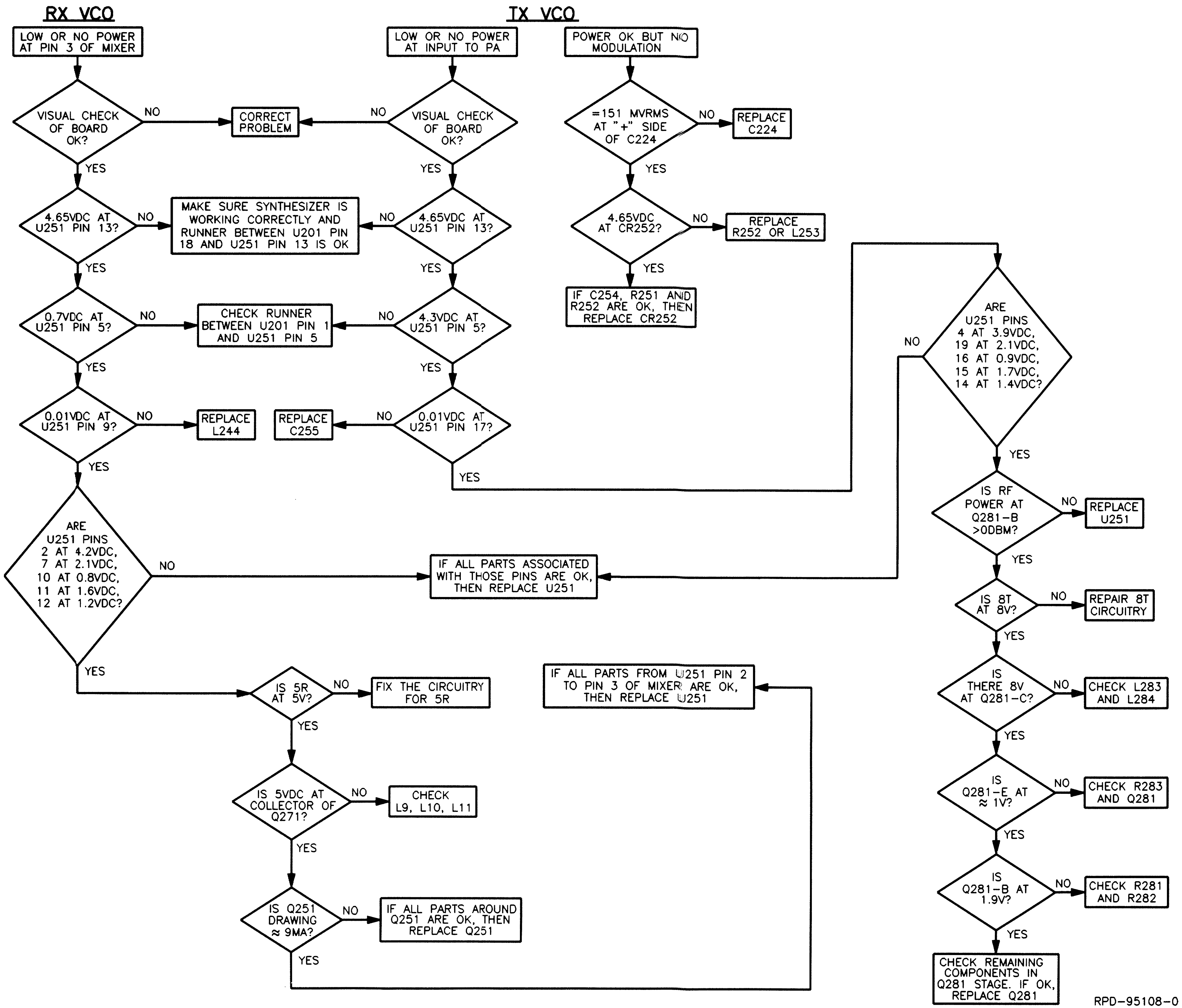
Troubleshooting Flow Chart for Receiver (All Models)



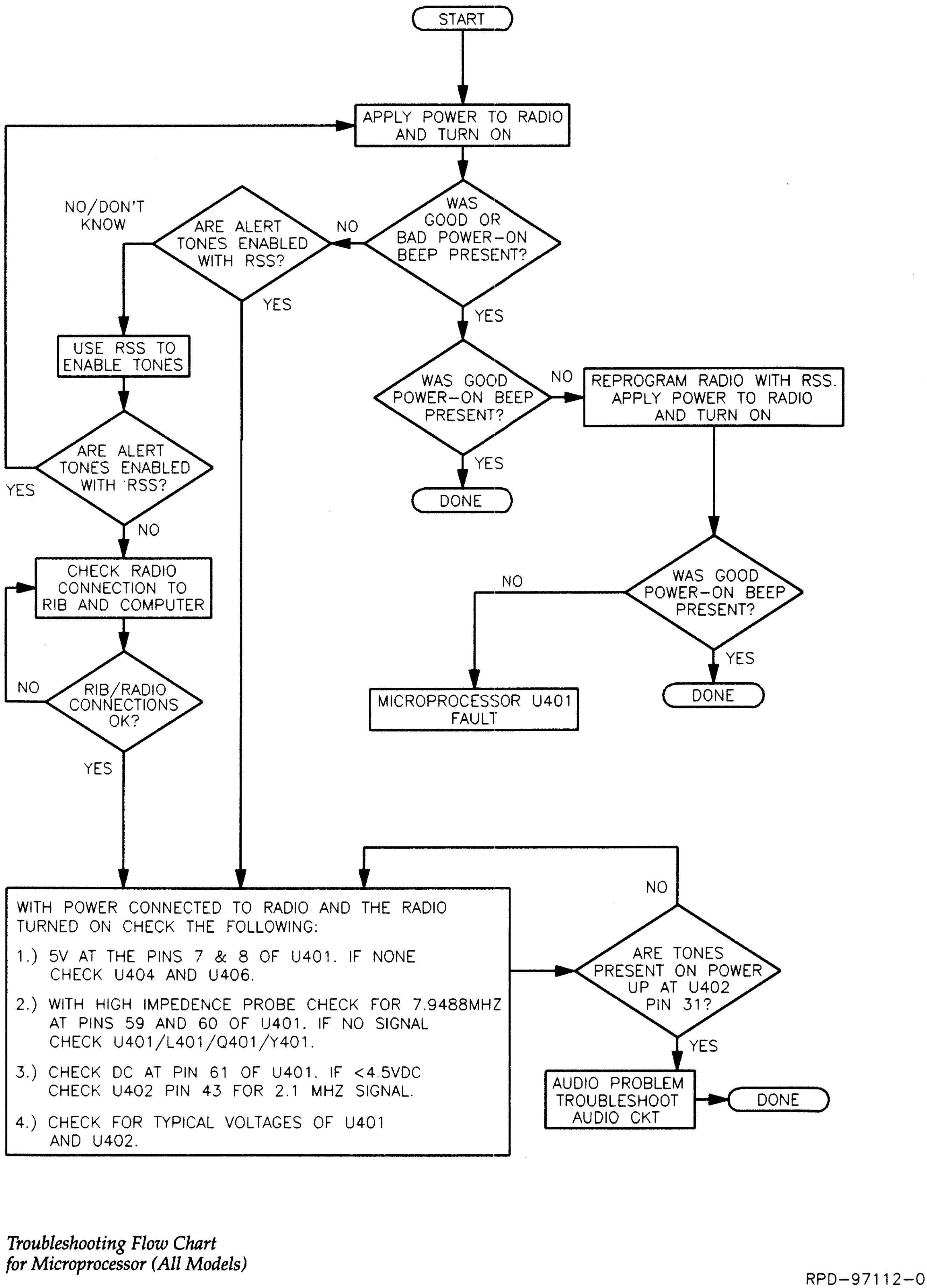
Troubleshooting Flow Chart
for Transmitter (All Models)



Troubleshooting Flow Chart
for Synthesizer (All Models)



Troubleshooting Flow Chart for VCO (All Models)



Troubleshooting Flow Chart
for Microprocessor (All Models)

Section 4
Expanded Accessory Connector

General

The following is a description of the pin functions on the Expanded Accessory Connector for the M1225 mobile radio. Refer to Figure 1 for pin locations in the connector housing.

Pin	Description	Application
1	External Speaker (–)	Connect external 8-ohm speaker to pins 1 and 16. CAUTION: Bridge-type output. Neither pin 1 nor 16 is ground.
2	External Mic Audio	Input impedance: 500 ohms. 80 mV rms at 1 kHz for 60% deviation. This path is enabled when external mic PTT is keyed.
3	External Mic PTT	Pull this pin low (less than 1.8 V dc) to key transmitter and enable external mic audio path. This pin is pulled low via a diode when front panel mic PTT is pulled low to allow sensing of mic PTT by accessory. This pin is pulled high to 5 V dc via 9.6 k ohms.
4	Programmable Output	Defaults to External Alarm. Provides an active high to 13.8 V dc battery supply. Maximum current: 0.25 amps. Refer to "Programmable Pins" below.
5	Flat Tx Audio Input	Input impedance: 35k ohms. 150 mV rms for 60% deviation. May be programmed to bypass limiter using RSS.
6	Programmable Input	Refer to "Programmable Pin."
7	Ground	
8	Programmable Input/Output	Defaults to COR carrier detect. Refer to "Programmable Pins."
9	Programmable Input	Defaults to Emergency Switch. Refer to "Programmable Pins."
10	Ignition Sense	Remove fuse F401 and connect this pin to vehicle ignition-controlled voltage source for ignition-controlled radio on-off. CAUTION: Accidentally shorting this pin to ground will blow internal fuse F401.
11	Rx Audio Output	330 mV rms (at 1 kHz if de-emphasized) at 60% deviation. Minimum load resistance: 5k ohms. Default is de-emphasized, muted. May be programmed for non-de-emphasized, unmuted using RSS.
12	Programmable Input/Output	Refer to "Programmable Pins."
13	Switched A+ Sense	13.8 V dc source for accessories when radio is turned on. Maximum current: 0.5 amps. CAUTION: Accidentally shorting this pin to ground with radio turned on will blow internal fuse F401.
14	Programmable Input/Output	Refer to "Programmable Pins."
15	Internal Speaker (+)	If jumper JU501 is removed, connect to pin 16 to enable internal speaker. NOTE: If the HLN3145 Public Address and Speaker A/B Switch kit is used, jumper JU501 must be removed if it is desired to mute the internal speaker when the switch is in position B.
16	External Speaker (+)	Connect external 8-ohm speaker to pins 1 and 16. CAUTION: Bridge-type output. Neither pin 1 nor 16 is ground.

Programmable Pins

Pins 4, 6, 8, 9, 12, and 14 are programmable I/O's. The functions of the pins can be assigned using RSS. Information on the available functions and how to program them is contained in the RSS help files in the Appendices section.

Pin 4 is an output only. It provides an active high to the 13.8 V dc battery supply (0.25 amps maximum), otherwise it is pulled low via 10k ohms.

Pin 6 and 9 are inputs only. They are normally pulled high to 5 V dc via 4.7k ohms. To activate the input, it should be pulled low to within 0.7 V dc of ground.

Pin 8, 12, and 14 may each be programmed as either an input or output. If programmed as an input, the pin is pulled high to 5 V dc via 4.7k ohms. To activate the input, it should be pulled low to within 0.7 V dc of ground. If programmed as an output, the pin is normally pulled high to 5 V dc via 4.7k ohms. When enabled, the output goes active low. Maximum sinking current is 50 mA.

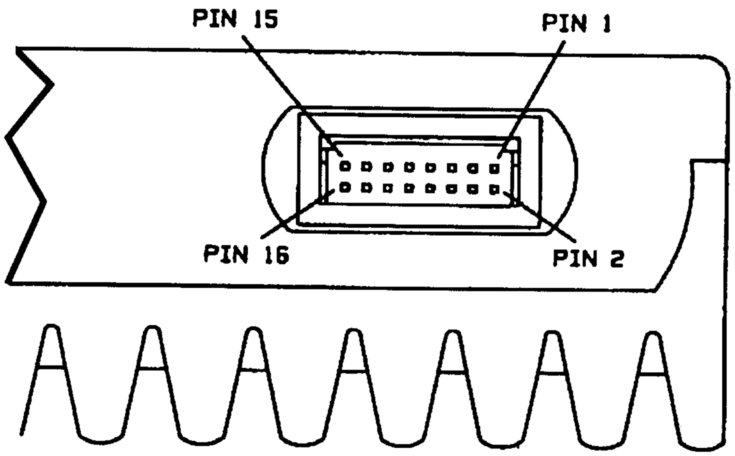
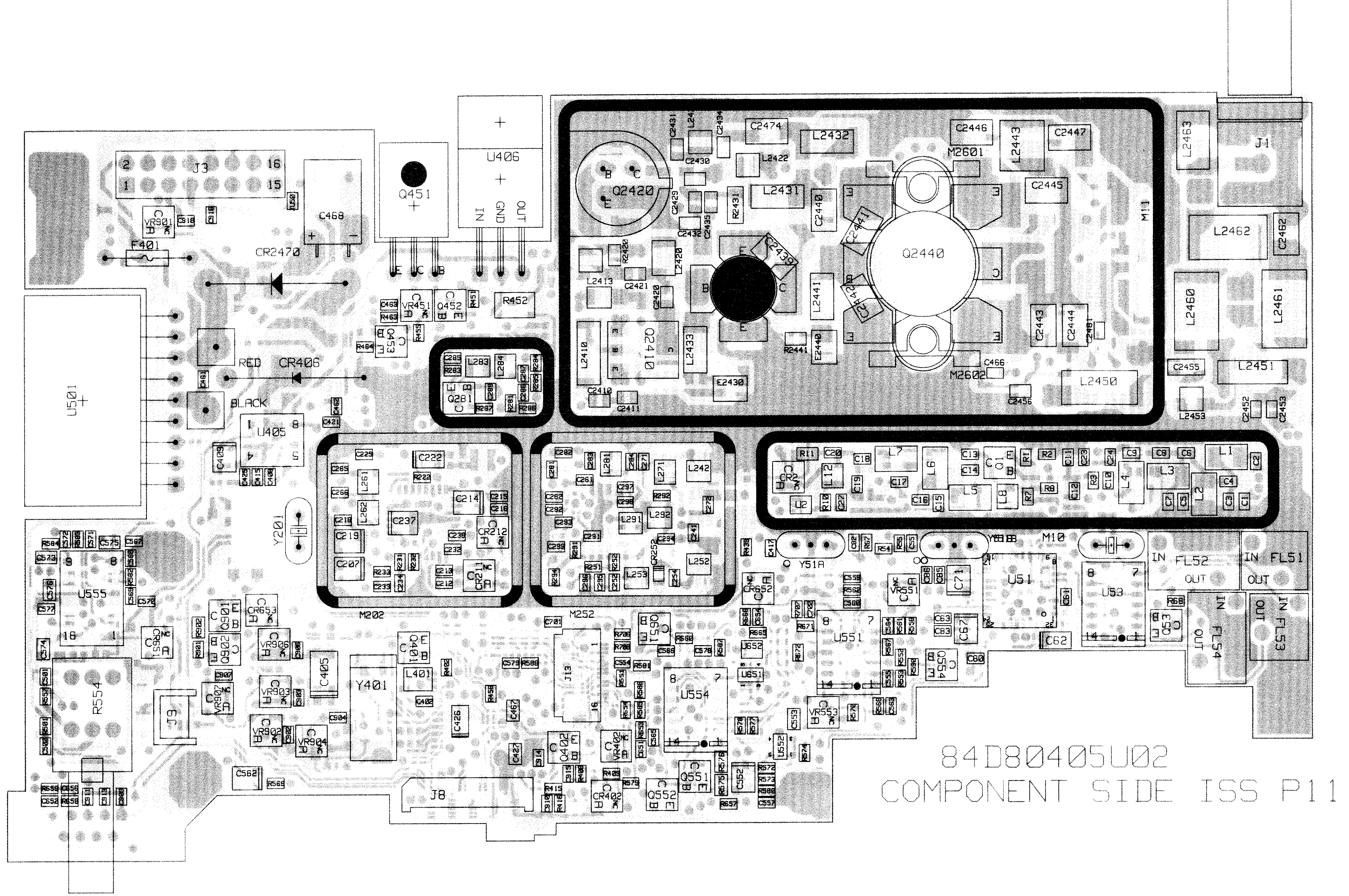
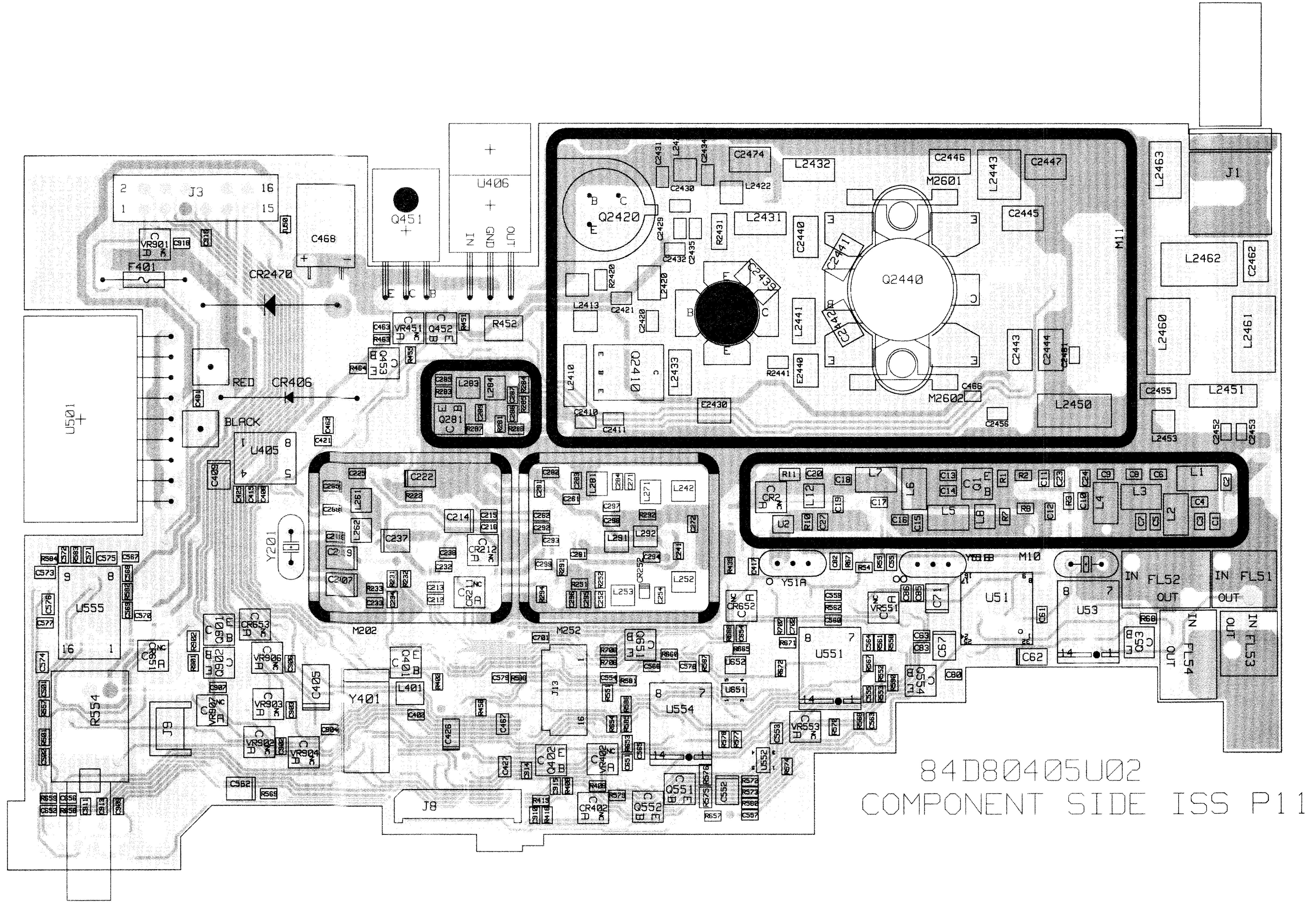


Figure 4-1. Expanded Accessory Connector Pin Locations (viewed from rear of radio)



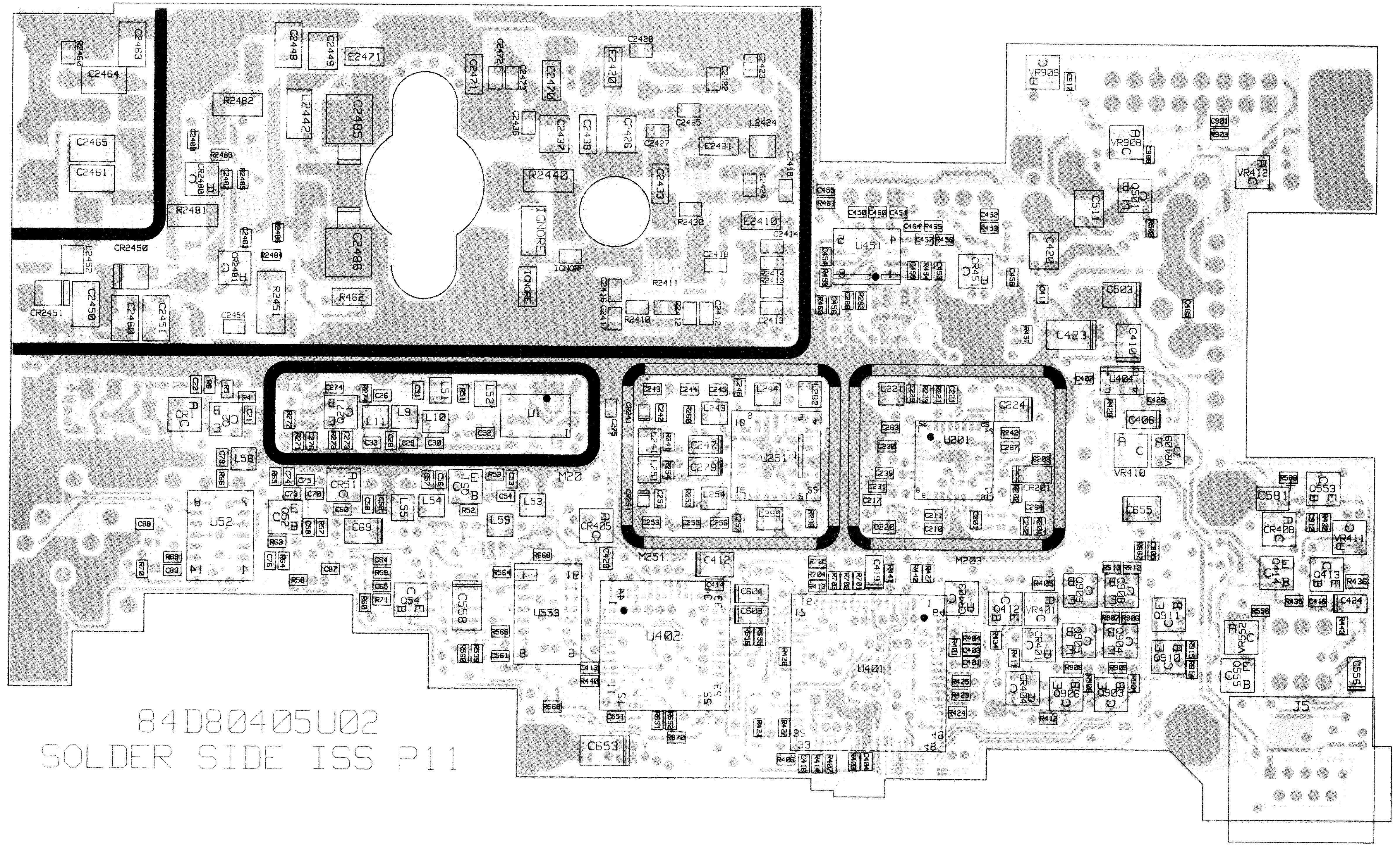
COMPONENT SIDE (GRAY) RCB-97101-O
SOLDER SIDE (PINK) RCB-97104-O
OVERLAY ----- RCB-97105-O

COMPONENT SIDE VIEW



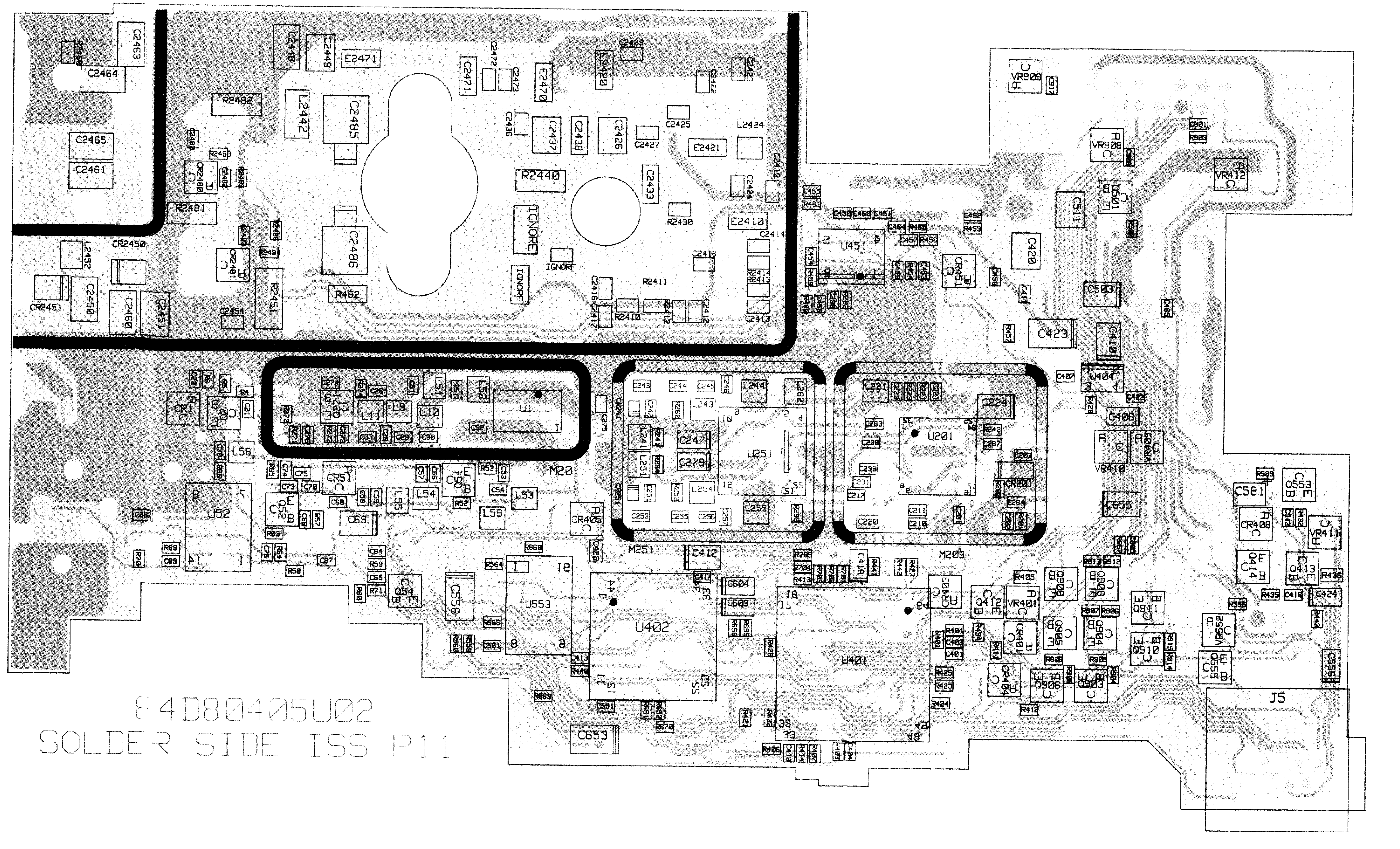
COMPONENT SIDE INNER LAYER (GRAY) RCB-97102-O
SOLDER SIDE INNER LAYER (PINK) RCB-97103-O
OVERLAY ----- RCB-97105-O

COMPONENT SIDE VIEW



COMPONENT SIDE (GRAY) RCB-97101-O (REV)
SOLDER SIDE (PINK) RCB-97104-O (REV)
OVERLAY ----- RCB-97106-O

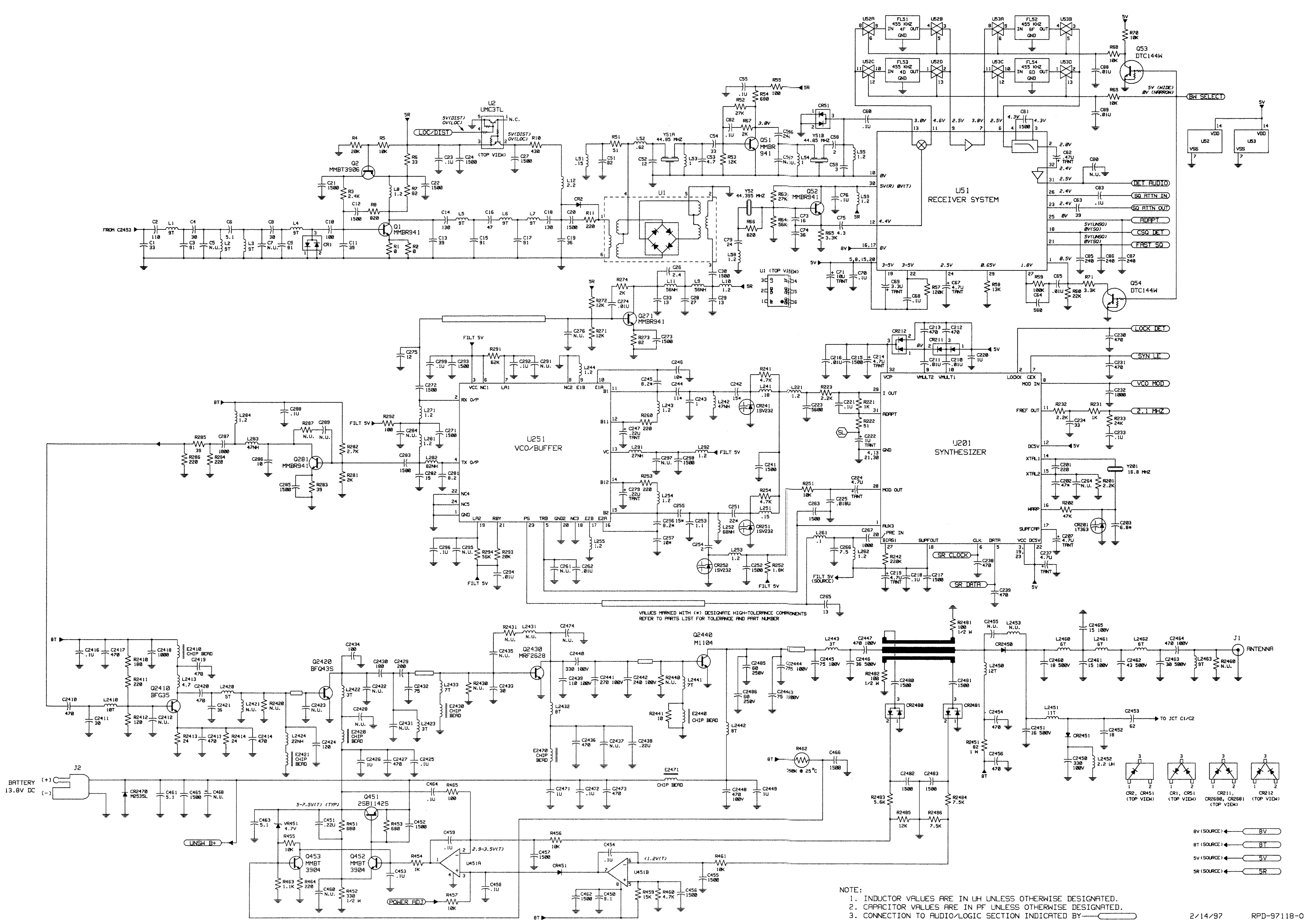
SOLDER SIDE VIEW



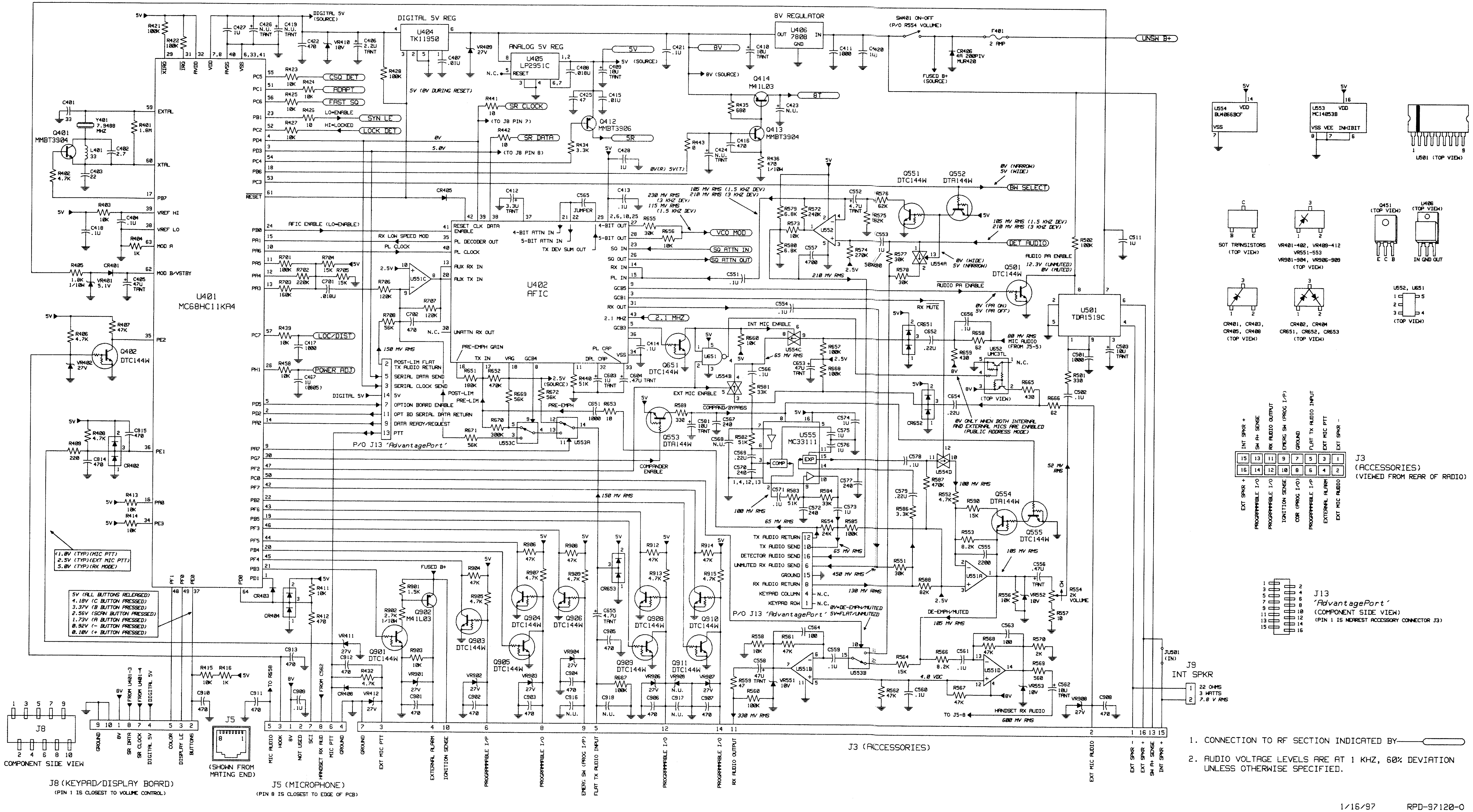
COMPONENT SIDE INNER LAYER (GRAY) RCB-97102-O (REV)
SOLDER SIDE INNER LAYER (PINK) RCB-97103-O (REV)
OVERLAY ----- RCB-97106-O

SOLDER SIDE VIEW

Circuit Board Details for
VHF Main Boards, 150-174 MHz, 12.5 & 25 kHz, 25-40 W
(Part of HUD3233C & HUD3251A Radios)



Schematic Diagram for
VHF Main Boards, 150-174 MHz, 12.5 & 25 kHz, 25-40 W
(Part of HUD3233C & HUD3251A Radios)
(Sheet 1 of 2)



Schematic Diagram for
VHF Main Boards, 150-174 MHz, 12.5 & 25 kHz, 25-40 W
(Part of HUD3233C & HUD3251A Radios)
(Sheet 2 of 2)

Parts List

HUD3233C & HUD3251A VHF Radio, 12.5/25 kHz,
150-174 MHz, 25-40 W PL-971001-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF +/-5%; 50 V: unless otherwise stated
C1	21-13740F39	33 pF
C2	21-13740F52	110 pF
C3	21-13740F50	91 pF
C4	21-13740F38	30 pF
C5	---	Not Used
C6	21-13740F20	5.1 ±0.25 pF
C7	---	Not Used
C8	21-13740F38	30 pF
C9	21-13740F50	91 pF
C10	21-13740F51	100 pF
C11	21-13740F41	39 pF
C12	21-13741F29	1500 pF
C13	21-13740F41	39 pF
C14	21-13740F54	130 pF
C15	21-13740F50	91 pF
C16	21-13740F43	47 pF
C17	21-13740F50	91 pF
C18	21-13740F54	130 pF
C19	21-13740F40	36 pF
C20	21-13741F29	1500 pF
C21, 22	21-13741F29	1500 pF
C23	21-13743E20	0.1 uF, 10%; 16 V
C24	21-13741F29	1500 pF
C26	21-13740F12	2.4 ±0.25 pF
C27	21-13741F29	1500 pF
C28	21-13740F37	27 pF
C29	21-13740F30	13 pF
C30	21-13741F29	1500 pF
C33	21-13740F30	13 pF
C51	21-13740F49	82 pF
C52	21-13740F29	12 pF
C53	21-13740F19	4.7 ±0.25 pF
C54	21-13740F39	33 pF
C55	21-13743E20	0.1 uF, 10%; 16V
C56	21-13740F36	24 pF
C57	---	Not Used
C58	21-13740F10	2 ±0.25 pF
C59	21-13740F14	3 ±0.25 pF
C60	21-13743E20	0.1 uF, 10%; 16 V
C61	21-13741F29	1500 pF
C62	23-11049A05	tantalum 0.47 uF, 10%; 25 V
C63	21-13740F41	39 pF
C64	21-13740F69	560 pF
C65	21-13741F49	.01 uF
C67	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C68	21-13743E20	0.1 uF, 10%; 16V
C69	23-11049J07	tantalum 3.3 uF, 10%; 20 V
C70	21-13743E20	0.1 uF, 10%; 16V
C71	23-11049A57	tantalum 10 uF, 10%; 16 V
C73	21-13740F32	16 pF
C74	21-13740F40	36 pF
C75	21-13740F18	4.3 ±0.25 pF
C76	21-13743E20	0.1 uF, 10%; 16 V
C79	21-13740F36	24 pF
C80	---	Not Used
C82, 83	21-13743E20	0.1 uF, 10%; 16 V
C85 thru 87	21-13740F60	240 pF
C88, 89	21-13741F49	.01 uF
C201	21-13740F59	220 pF
C202	21-13740L34	47 pF, 2%
C203	21-13740L14	6.8 ±0.1 pF
C207	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C210, 211	21-13741F49	.01 uF
C212, 213	21-13741F17	470 pF
C214	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C215	21-13741F29	1500 pF
C216	21-13741F49	.01 uF
C217	21-13741F29	1500 pF
C218	21-13743E20	0.1 uF, 10%; 16 V
C219	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C220	21-13928E01	1 uF, 10%; 10V
C221	21-13743E20	0.1 uF, 10%; 16V
C222	23-11049A07	tantalum 1 uF, 10%; 16 V
C223	21-13741F43	5600 pF
C224	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C225	21-13743E05	.018 uF, 10%; 16 V
C230, 231	21-13741F17	470 pF
C232	21-13741F25	1000 pF
C233	21-13743E20	0.1 uF, 10%; 16 V
C234	21-13740F39	33 pF
C237	23-11049J11	tantalum 4.7 uF, 10%; 16 V

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C238	21-13741F17	470 pF
C239	21-13741F17	470 pF
C241	21-13741F29	1500 pF
C242	21-13740L22	15 pF, 2%
C243	21-13740F03	1 ±0.25 pF
C244	21-13740L19	11 pF, 2%
C245	21-13740L16	8.2, ±0.1 pF
C246	21-13740L18	10 pF, 2%
C247	23-11049A03	tantalum 0.22 uF, 10%; 35 V
C251	21-13740L26	22 pF, 2%
C252	21-13741F29	1500 pF
C253	21-13740F04	1.1 ±0.25 pF
C254	21-13740F10	2 ±0.25 pF
C255	21-13740L22	15 pF, 2%
C256	21-13740L16	8.2 ±0.1 pF
C257	21-13740L18	10 pF, 2%
C261	---	Not Used
C262	21-13741F49	.01 uF
C263	21-13741F29	1500 pF
C264	---	Not Used
C265	21-13740F30	13 pF
C266	21-13740F24	7.5 ±0.25 pF
C267	21-13741F25	1000 pF
C271 thru 273	21-13741F29	1500 pF
C274	21-13741F49	.01 uF
C275	21-13740F29	12 pF
C276	---	Not Used
C279	23-11049A03	tantalum 0.22 uF, 10%; 35 V
C281	21-13740F25	8.2 ±0.25 pF
C282	21-13740F31	15 pF
C283	21-13741F29	1500 pF
C284	---	Not Used
C285	21-13741F29	1500 pF
C286	21-13740F27	10 pF
C287	21-13741F25	1000 pF
C288	21-13743E20	0.1 uF, 10%; 16 V
C289	---	Not Used
C291	---	Not Used
C292	21-13743E20	0.1 uF, 10%; 16 V
C293	21-13741F29	1500 pF
C294	21-13741F49	.01 uF
C295	---	Not Used
C296	21-13743E20	0.1 uF, 10%; 16 V
C297	---	Not Used
C298	21-13741F29	1500 pF
C299	21-13743E20	0.1 uF, 10%; 16 V
C401	21-13740F39	33 pF
C402	21-13740F13	2.7 ±0.25 pF
C403	21-13740F35	22 pF
C404	21-13743E20	0.1 uF, 10%; 16 V
C405	23-11049J43	tantalum 47 uF, 10%; 10 V
C406	23-11049A40	tantalum 2.2 uF, 10%; 10 V
C407	21-13741F49	.01 uF
C408	21-13743E05	.018 uF, 10%; 16V
C409, 410	23-11049A57	tantalum 10 uF, 10%; 16 V
C411	21-13741F25	1000 pF
C412	23-11049J07	tantalum 3.3 uF, 10%; 20 V
C413, 414	21-13743E20	0.1 uF, 10%; 16 V
C415	21-13741F49	.01 uF
C416	21-13741F17	470 pF
C417	21-13741F25	1000 pF
C418	21-13743E20	0.1 uF, 10%; 16 V
C419	---	Not Used
C420	21-13741W01	1 uF, 10%; 25 V
C421	21-13743E20	0.1 uF, 10%; 16 V
C422	21-13741F17	470 pF
C423, 424	---	Not Used
C425	21-13740F43	47 pF
C426	---	Not Used
C427, 428	21-13928E01	1 uF, 10%; 10 V
C450	21-13740F26	9.1 ±0.25 pF
C451	21-13743K16	0.22 uF, +80/-20%; 16 V
C452	21-13741F29	1500 pF
C453, 454	21-13743E20	0.1 uF, 10%; 16 V
C455 thru 457	21-13741F29	1500 pF
C458, 459	21-13743E20	0.1 uF, 10%; 16 V
C460	---	Not Used
C461	21-13740F20	5.1 ±0.25 pF
C462	21-13741F29	1500 pF
C463, 464	21-13740F20	5.1 ±0.25 pF
C465, 466	21-13741F29	1500 pF
C467	21-13928E01	1 uF, 10%; 10 V
C468	---	Not Used

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C501	21-13741F25	1000 pF
C502	21-13743E20	0.1 uF, 10%; 16 V
C503	23-11049A57	tantalum 10 uF, 10%; 16 V
C511	21-13741W01	1 uF, 10%; 25 V
C551	21-13743E20	0.1 uF, 10%; 16 V
C552	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C553	21-13928E01	1 uF, 10%; 10 V
C554	21-13743E20	0.1 uF, 10%; 16 V
C555	21-13741F33	2200 pF
C556	23-11049A05	tantalum 0.47 uF, 10%; 25 V
C557	21-13741F41	4700 pF
C558	23-11049J43	tantalum 47 uF, 10%; 10 V
C559 thru 561	21-13743E20	0.1 uF, 10%; 16 V
C562	23-11049A57	tantalum 10 uF, 10%; 16 V
C563, 546	21-13740F51	100 pF
C565	06-62057B47	jumper
C566	21-13743E20	0.1 uF, 10%; 16 V
C567	21-13740F60	240 pF
C568	---	Not Used
C569	21-13743K16	0.22 uF, +80/-20%; 16 V
C570	21-13740F60	240 pF
C571	21-13743E20	0.1 uF, 10%; 16 V
C572	21-13740F60	240 pF
C573 thru 576	21-13928E01	1 uF, 10%; 10 V
C577	21-13740F60	240 pF
C578	21-13743E20	0.1 uF, 10%; 16 V
C579	21-13743K16	0.22 uF, +80/-20%; 16 V
C581	23-11049A57	tantalum 10 uF, 10%; 16 V
C603	23-11049A07	tantalum 1 uF, 10%; 16 V
C604	23-11049A05	tantalum 0.47 uF, 10%; 25 V
C651	21-13741F25	1000 pF
C652	21-13743K16	0.22 uF, +80/-20%; 16 V
C653	23-11049J43	tantalum 47 uF, 10%; 10 V
C654	21-13743K16	0.22 uF, +80/-20%; 16 V
C655	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C656	21-13743E20	0.1 uF, 10%; 16 V
C701	21-13743E05	.018 uF, 10%; 16 V
C702	21-13741F17	470 pF
C901 thru 908	21-13741F17	470 pF
C909	21-13743E20	0.1 uF, 10%; 16 V
C910 thru 915	21-13741F17	470 pF
C916 thru 918	---	Not Used
C2410	21-13740A71	470 pF
C2411	21-13740A40	30 pF
C2412	---	Not Used
C2413, 2414	21-13740A71	470 pF
C2416	21-13743A19	0.1 uF, 10%; 16 V
C2417	21-13740A71	470 pF
C2418	21-13740A79	1000 pF
C2419, 2420	21-13740A71	470 pF
C2421	21-13740A42	36 pF
C2422, 2423	--	Not Used
C2424	21-13740A57	120 pF
C2425	21-13743A19	0.1 uF, 10%; 16 V
C2426	21-13741W01	1 uF, 10%; 25 V
C2427	21-13740A71	470 pF
C2428	---	Not Used
C2429	21-13740A62	200 pF
C2430	21-13740A61	180 pF
C2431	--	Not Used
C2432	21-13740A52	75 pF
C2433	21-13740B36	30 pF
C2434	21-13740A55	100 pF
C2435	---	Not Used
C2436	21-13740A71	470 pF
C2437	---	Not Used
C2438	21-11032B15	0.22 uF, +80/-20%
C2439	21-11078B43	110 pF; 100 V
C2440	21-11078B55	330 pF; 100 V
C2441	21-11078B53	270 pF; 100 V
C2442	21-11078B52	240 pF; 100 V
C2443, 2444	21-11078B39	75 pF; 100 V
C2445	21-11078B39	75 pF; 100 V
C2446	21-80060M32	36 pF; 500 V
C2447, 2448	21-11078B59	470 pF; 100 V
C2449	21-13741W01	1 uF, 10%; 25 V
C2450	21-11078B55	330 pF; 100 V
C2451	21-80060M24	16 pF; 500 V
C2452	21-13740F33	18 pF
C2453	21-13740F46	62 pF
C2454	21-13740A71	470 pF
C2455	---	Not Used
C2456	21-13740A71	470 pF

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C2460	21-80060M25	18 pF; 500 V
C2461	21-11078B18	15 pF; 100 V
C2462	21-80060M34	43 pF; 500 V
C2463	21-80060M30	30 pF; 500 V
C2464	21-11078B59	470 pF; 100 V
C2465	21-11078B18	15 pF; 100 V
C2471	21-13741W01	1 uF, 10%; 25 V
C2472	21-13743A19	0.1 uF, 10%; 16 V
C2473	21-13740A71	470 pF
C2474	---	Not Used
C2480 thru 2483	21-13741F29	1500 pF
C2485, 2486	21-80464E52	clamped mica 60 pF; 250 V
		diode: (see note)
CR1	48-80154K03	dual Schottky SOT
CR2	48-80142L01	silicon PIN SOT MMBV3401
CR51	48-80154K03	dual Schottky SOT
CR201	48-02245J22	silicon varactor SOT 1T363
CR211	48-13833C07	dual silicon SOT MMBD7000
CR212	48-05218N57	dual silicon SOT
CR241	48-62824C03	silicon varactor SOT 1SV232
CR251, 252	48-62824C03	silicon varactor SOT 1SV232
CR401	48-05129M76	silicon SOT
CR402	48-13833C07	dual silicon SOT MMBD7000
CR403	48-80939T01	Schottky SOT
CR404	48-13833C07	dual silicon SOT MMBD7000
CR405	48-05129M76	silicon SOT
CR406	48-83553T02	4A 200 PIV MUR420
CR408	48-05129M76	silicon SOT
CR451	48-05129M76	silicon SOT
CR651 thru 653	48-13833C07	dual silicon SOT MMBD7000
CR2450, 2451	48-02482J02	silicon PIN MA4P1250
CR2470	48-80236E07	transient suppressor
CR2480, 2481	48-82290T02	dual Schottky SOT HSMS-2802
		ferrite beads:
E2410	24-84657R01	ferrite bead
E2420, 2421	24-84657R01	ferrite bead
E2430	24-84657R01	ferrite bead
E2440	24-84657R01	ferrite bead
E2470, 2471	24-84657R01	ferrite bead
		fuse:
F401	65-05214E04	2 amp axial lead
		filter:
FL51	91-80098D14	455 kHz 4F
FL52	91-80097D04	455 kHz 6F
FL53	91-80098D16	455 kHz 4D
FL54	91-80097D16	455 kHz 6D
		connector, receptacle:
J1	09-80476U01	mini UHF coax
J2	30-04510J01	power cable assembly (includes J2)
J3	28-04503J01	16-pin, accessories
J5	09-04426J01	telephone type, 8 contact, microphone
J8	09-04422J01	10 pin, display board
J9	28-04423J01	2-pin, internal speaker
J13	09-80472U01	16-pin, option board
		jumper:
JU501	06-62057B47	jumper
		coil, rf:
L1 thru 7	24-60591G24	9 turns
L8	24-62587X69	chip 1.2 uH; 5%
L9	24-62587X50	chip 56 nH; 5%
L10	24-62587X69	chip 1.2 uH; 5%
L11	24-62587X50	chip 56 nH; 5%
L12	24-62587N72	chip 2.2 uH; 5%
L51	24-62587X55	chip 0.15 uH; 5%
L52	24-62587X63	chip 0.62 uH; 5%
L53, 54	24-62587X68	chip 1 uH; 5%
L55	24-62587X69	chip 1.2 uH; 5%
L58, 59	24-62587X69	chip 1.2 uH; 5%
L221	24-62587X69	chip 1.2 uH; 5%
L241	24-62587V37	chip 0.18 uH; 5%
L242	24-62587X49	chip 47 nH; 5%
L243, 244	24-62587X69	chip 1.2 uH; 5%
L251	24-62587V36	chip 0.15 uH; 5%
L252	24-62587X51	chip 68 nH; 5%
L253 thru 255	24-62587X69	chip 1.2 uH; 5%
L261	24-62587X53	chip 0.1 uH; 5%

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L262	24-62587X69	chip 1.2 uH; 5%
L271	24-62587X69	chip 1.2 uH; 5%
L281	24-62587X69	chip 1.2 uH; 5%
L282	24-62587X52	chip 82 nH; 5%
L283	24-62587X49	chip 47 nH; 5%
L284	24-62587X69	chip 1.2 uH; 5%
L291	24-62587X46	chip 27 nH; 5%
L292	24-62587X69	chip 1.2 uH; 5%
L401	24-60578C43	chip 33 uH
L2410	24-60591H77	10 turns
L2413	24-62587N76	chip 4.7 uH; 5%
L2420	24-60591C73	5 turns
L2421	---	Not Used
L2422, 2423	24-60591A49	3 turns
L2424	24-62587X45	chip 22 nH; 5%
L2431	---	Not Used
L2432	24-60591F77	8 turns
L2433	24-60591E77	7 turns
L2441, 2442	24-60591E77	7 turns
L2443	24-60591X01	3 turns
L2450	24-60591V77	12 turns
L2451	24-60591J77	11 turns
L2452	24-11087B30	chip 2.2 uH
L2453	---	Not Used
L2460 thru 2462	24-60591X04	6 turns
L2463	24-60591S77	9 turns
		transistor: (see note)
Q1	48-13827A07	NPN; type MMBR941
Q2	48-13824A17	PNP; type MMBT3906
Q51, 52	48-13827A07	NPN; type MMBR941
Q53, 54	48-80947V01	digital NPN; type DTC144W
Q271	48-13827A07	NPN; type MMBR941
Q281	48-13827A07	NPN; type MMBR941
Q401	48-80214G02	NPN; type MMBT3904
Q402	48-80947V01	digital NPN; type DTC144W
Q412	48-13824A17	PNP; type MMBT3906
Q413	48-80214G02	NPN; type MMBT3904
Q414	48-80141L03	PNP; type BCW68G
Q451	48-02245J25	PNP; type 2SB1142S
Q452, 453	48-80214G02	NPN; type MMBT3904
Q501	48-80947V01	digital NPN; type DTC144W
Q551	48-80947V01	digital NPN; type DTC144W
Q552 thru 554	48-80494U01	digital PNP; type DTA144W
Q555	48-80947V01	digital NPN; type DTC144W
Q651	48-80947V01	digital NPN; type DTC144W
Q901	48-80947V01	digital NPN; type DTC144W
Q902	48-80141L03	PNP; type BCW68G
Q903 thru 906	48-80947V01	digital NPN; type DTC144W
Q908 thru 911	48-80947V01	digital NPN; type DTC144W
Q2410	48-02245J24	NPN; type BFG35
Q2420	48-02245J28	NPN; type BFQ43S
Q2430	48-80225C18	NPN; type MRF2628
Q2440	48-84411L04	NPN; type M1104
		resistor, fixed: +/-5%; 1/16 W: unless otherwise stated
R1, 2	06-62057B47	0
R3	06-62057A58	2.4k
R4	06-62057A80	20k
R5	06-62057A73	10k
R6	06-62057A13	33
R7	06-62057A23	82
R8	06-62057A47	820
R10	06-62057A40	430
R11	06-62057C59	220; 1/10 watt
R51	06-62057A18	51
R52	06-62057A83	27k
R53	06-62057A75	12k
R54	06-62057A45	680
R55	06-62057A25	100
R57	06-62057A99	120k
R58	06-62057A76	13k
R59	06-62057A97	100k
R60	06-62057A81	22k
R63	06-62057A83	27k
R64	06-62057A91	56k
R65	06-62057A61	3.3k
R66	06-62057A47	820
R67	06-62057A56	2k
R68 thru 70	06-62057A73	10k
R71	06-62057A61	3.3k
R201	06-62057A57	2.2k

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R202	06-62057A89	47k
R221	06-62057A49	1k
R222	06-62057A18	51
R223	06-62057A57	2.2k
R231	06-62057A49	1k
R232	06-62057A57	2.2k
R233	06-62057A82	24k
R241	06-62057A65	4.7k
R242	06-62057B06	220k
R251	06-62057A73	10k
R252	06-62057A55	1.8k
R253	06-62057A33	220
R254	06-62057A65	4.7k
R260	06-62057A33	220
R271, 272	06-62057A75	12k
R273	06-62057A23	82
R274	06-62057A56	2k
R281	06-62057A56	2k
R282	06-62057A59	2.7k
R283	06-62057A15	39
R284	06-62057A33	220
R285	06-62057A15	39
R286	06-62057A33	220
R287	---	Not Used
R291	06-62057A92	62k
R292	06-62057A25	100
R293	06-62057A80	20k
R294	06-62057A91	56k
R401	06-62057B28	1.8 meg
R402	06-62057A65	4.7k
R403	06-62057A73	10k
R404	06-62057A49	1k
R405	06-62057C81	1.8k; 1/10 watt
R406	06-62057A65	4.7k
R407	06-62057A89	47k
R408	06-62057A65	4.7k
R409	06-62057A33	220
R411	06-62057A73	10k
R412	06-62057A41	470
R413 thru 415	06-62057A73	10k
R416	06-62057A49	1k
R421, 422	06-62057A97	100k
R423 thru 425	06-62057A73	10k
R426	06-62057A01	10
R427	06-62057A73	10k
R428	06-62057A97	100k
R432	06-62057A65	4.7k
R434	06-62057A61	3.3k
R435	06-62057A45	680
R436	06-62057C67	470; 1/10 watt
R439	06-62057A73	10k
R440	06-62057A90	51k
R441, 442	06-62057A01	10
R443	06-62057B47	0
R451	06-62057A45	680
R452	06-80195M37	330; 1/2 watt
R453	06-62057A45	680
R454	06-62057A49	1k
R455 thru 458	06-62057A73	10k
R459	06-62057A77	15k
R460	06-62057A65	4.7k
R461	06-62057A73	10k
R462	06-05621T02	thermistor 50k @ 25 degrees C
R463	06-62057A50	1.1k
R464	06-62057A33	220
R465	06-62057A25	100
R501	06-62057A37	330
R502	06-62057A97	100k
R551	06-62057A84	30k
R552	06-62057A65	4.7k
R553	06-62057A71	8.2k
R554	18-04405J02	variable 2k with switch
R556	06-62057A73	10k
R557	06-62057A01	10
R558	06-62057A73	10k
R559	06-62057A17	47
R560	06-62057A97	100k
R561, 562	06-62057A89	47k
R564	06-62057A77	15k
R566	06-62057A71	8.2k
R567, 568	06-62057A89	47k
R569	06-62057A43	560
R570	06-62057A56	2k

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R572	06-62057B07	240k
R573	06-62057A73	10k
R574	06-62057B08	270k
R575	06-62057A95	82k
R576	06-62057A92	62k
R577, 578	06-62057A84	30k
R579, 580	06-62057A69	6.8k
R581	06-62057A85	33k
R582, 583	06-62057A90	51k
R584	06-62057A85	33k
R585	06-62057A97	100k
R586	06-62057A61	3.3k
R587	06-62057B14	470k
R588	06-62057A95	82k
R589	06-62057A37	330
R590	06-62057A77	15k
R651	06-62057B04	180k
R652	06-62057B14	470k
R653	06-62057A01	10
R654	06-62057A82	24k
R655	06-62057A84	30k
R656	06-62057A73	10k
R657	06-62057A97	100k
R658	06-62057A20	62
R659	06-62057A40	430
R660	06-62057A73	10k
R665	06-62057A40	430
R666	06-62057A20	62
R667, 668	06-62057A97	100k
R669	06-62057A91	56k
R670	06-62057B09	300k
R671, 672	06-62057A91	56k
R701	06-62057A97	100k
R702	06-62057B06	220k
R703	06-62057B03	160k
R704, 705	06-62057A77	15k
R706, 707	06-62057A99	120k
R708	06-62057A91	56k
R901	06-62057A53	1.5k
R902	06-62057C85	2.7k; 1/10 watt
R903	06-62057A73	10k
R904	06-62057A89	47k
R905	06-62057A65	4.7k
R906	06-62057A89	47k
R907	06-62057A65	4.7k
R908	06-62057A89	47k
R909	06-62057A65	4.7k
R912	06-62057A89	47k
R913	06-62057A65	4.7k
R914	06-62057A89	47k
R915	06-62057A65	4.7k
R2410	06-62057C57	180; 1/10 watt
R2411	06-62057C59	220; 1/10 watt
R2412	06-62057C53	120; 1/10 watt
R2413, 2414	06-62057C36	24; 1/10 watt
R2420	---	Not Used
R2430, 2431	---	Not Used
R2440	---	Not Used
R2441	06-62057C27	10; 1/10 watt
R2451	06-80194M23	82; 1 watt
R2460	---	Not Used
R2481, 2482	06-80195M25	100; 1/2 watt
R2483	06-62057A67	5.6k
R2484	06-62057A73	10k
R2485	06-62057A75	12k
R2486	06-62057A56	2k
		integrated circuit: (see note)
U1	51-80505D05	double-balanced mixer
U2	48-09939C04	dual transistor switch UMC3TL
U51	51-80605E02	receiver system
U52, 53	51-05663U35	quad analog switch 4066B
U201*		synthesizer
U251	51-05414S84	VCO/buffer
U401*		microcomputer MC68HC11KA4
U402	51-80604E01	audio filter
U404	51-80633C01	5 V regulator TK11950
U405	51-05469E65	5 V regulator LP2951C
U406	51-13816D03	8 V regulator MC7808BT
U451	51-80932W01	dual op-amp LM2904 SOIC
U501	51-80147R01	audio power amp TDA1519C
U551	51-02198J28	quad op-amp LM2902D SOIC
U552	51-62852A09	single opamp LMC7101

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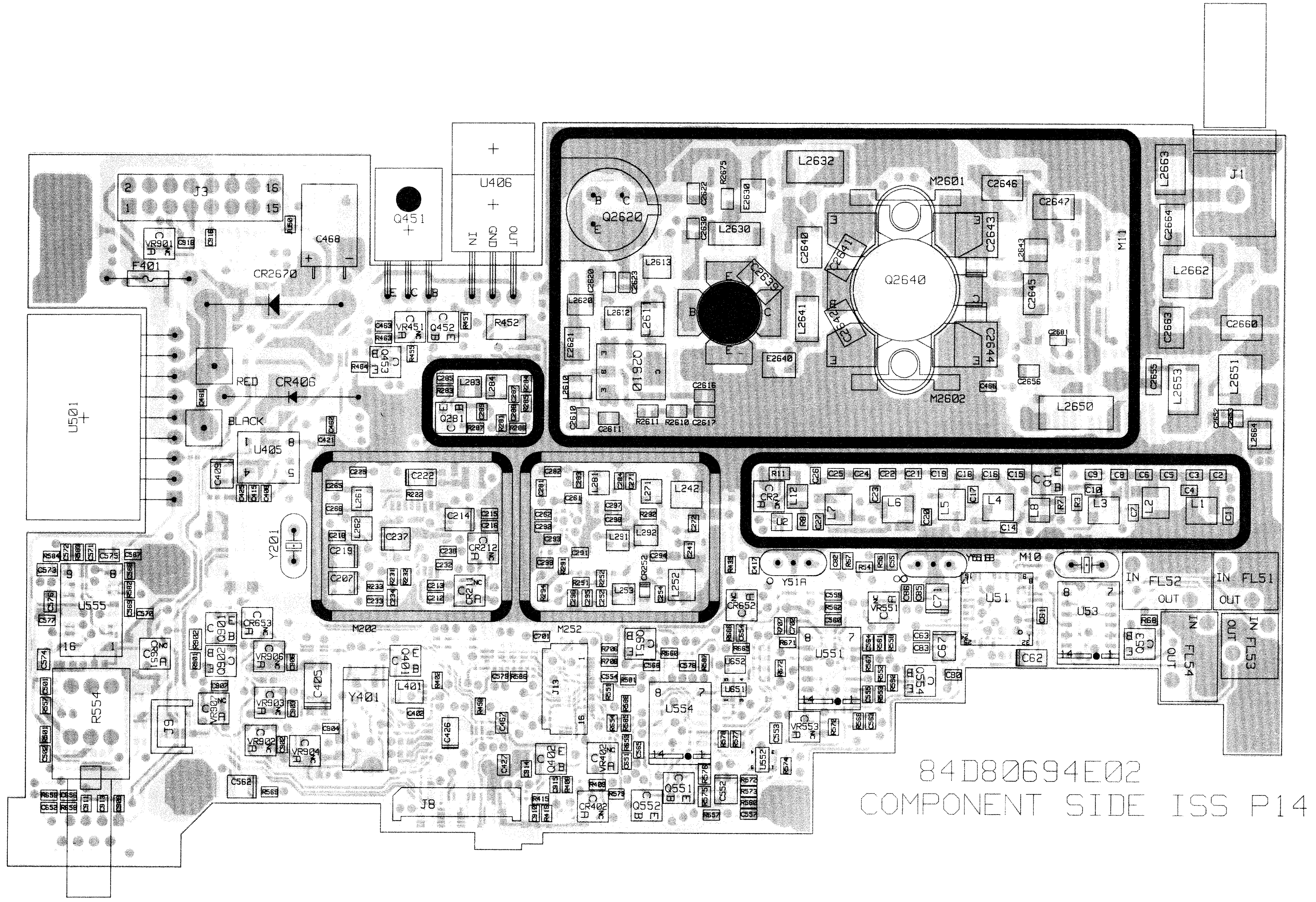
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
U553	51-84704M60	triple 2-channel switch 4053B
U554	51-05663U35	quad analog switch 4066B
U555	51-13811A35	compander MC33111
U651	51-05461G61	NAND gate TC7S00F
U652	48-09939C04	dual transistor switch UMC3TL
		voltage regulator: (see note)
VR401	48-80140L06	zener diode 5.1 V SOT
VR402	48-80948V01	zener diode 27 V SOT
VR409	48-80948V01	zener diode 27 V SOT
VR410	48-80140L15	zener diode 10 V SOT
VR411 412	48-80948V01	zener diode 27 V SOT
VR451	48-80140L05	zener diode 4.7 V SOT
VR551 thru 553	48-80140L15	zener diode 10 V SOT
VR901 thru 904	48-80948V01	zener diode 27 V SOT
VR906 thru 909	48-80948V01	zener diode 27 V SOT
		crystal: (see note)
Y51	91-80112R13	filter 44.85 MHz (includes Y51A and Y51B)
Y52	48-80606B07	44.395 MHz
Y201*		16.8 MHz
Y401	48-80113R01	7.9488 MHz
non-referenced items		
	14-05160A02	crystal insulator (for Y201)
	26-04398J01	VCO/synthesizer shield (4 used)
	26-04399J01	receiver mixer bottom shield
	26-04400J01	receiver front end top shield
	26-04419J01	PA shield frame
	26-04420J01	PA shield cover
	26-80481U01	Tx buffer top shield
	42-80281L01	ground clip (2 used for Q2640)

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

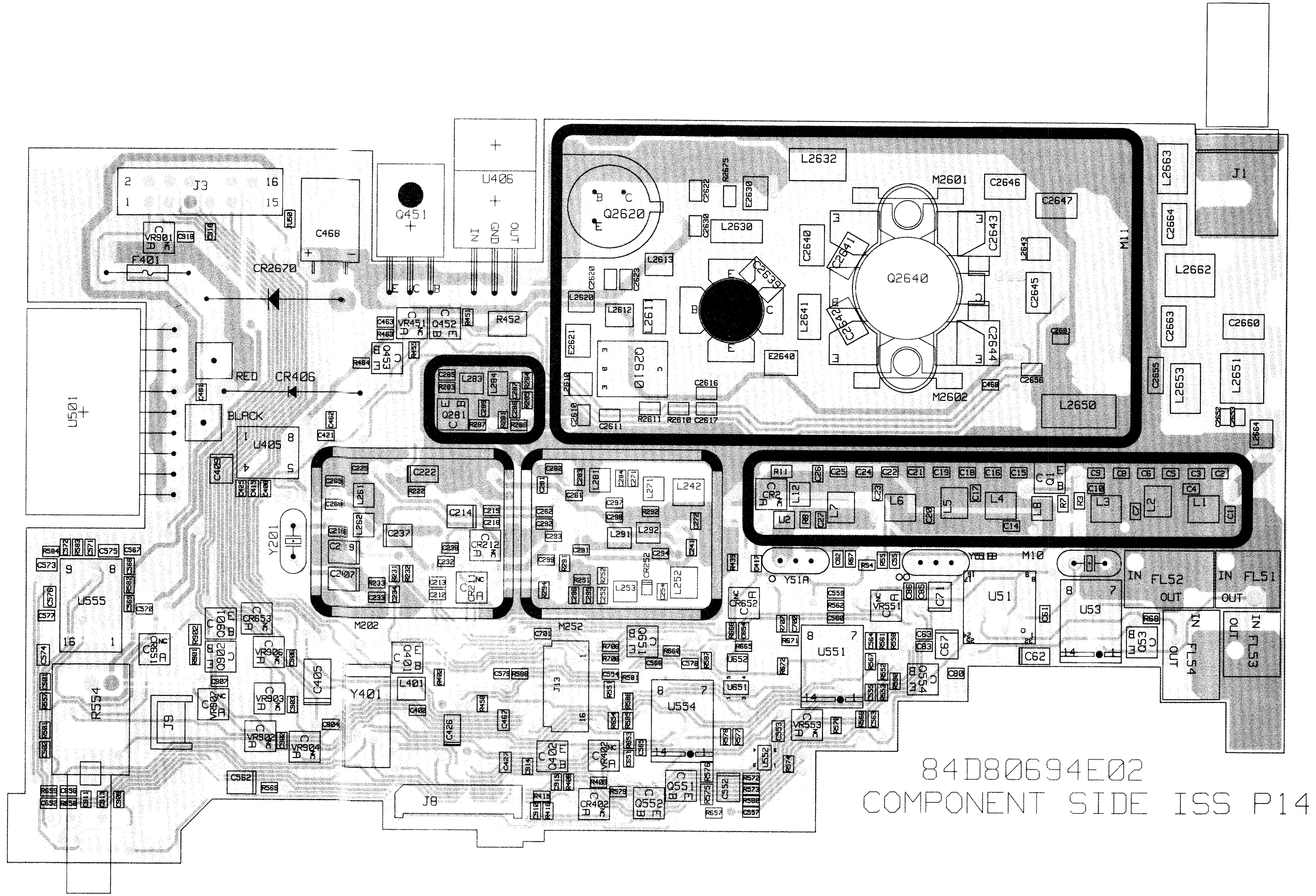
*Designators marked with an (*) denote parts which are not field serviceable. Recalibration of the radio using specialized factory equipment is mandatory when these components are replaced in order to guarantee the specified frequency stability of the radio at temperature extremes.

Parts List for
VHF Main Boards, 150-174 MHz, 12.5 & 25 kHz, 25-40 W
(Part of HUD3233C & HUD3251A Radios)



COMPONENT SIDE (GRAY) RCB-97107-O
SOLDER SIDE (PINK) RCB-97110-O
OVERLAY ----- RCB-97111-O

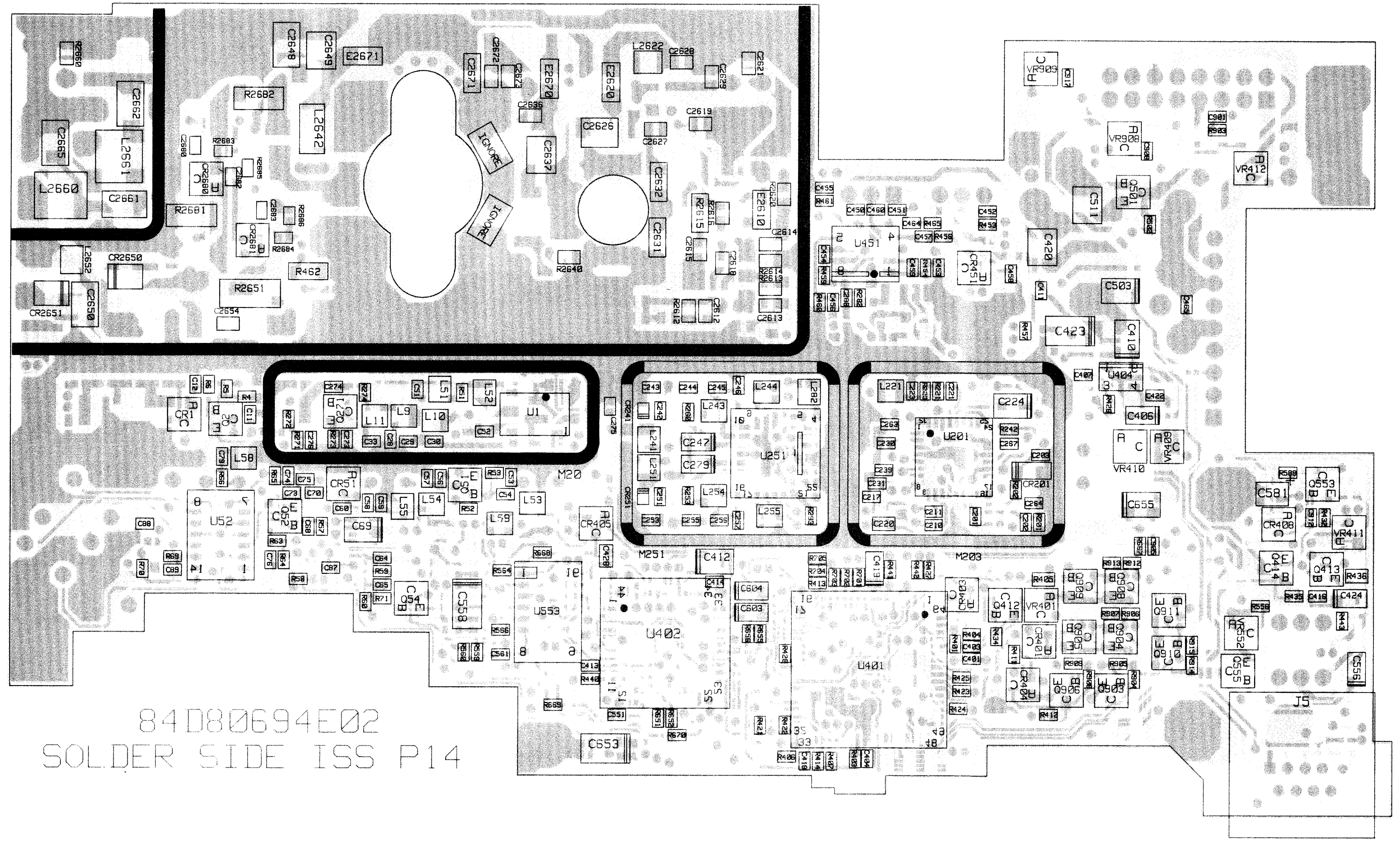
COMPONENT SIDE VIEW



COMPONENT SIDE INNER LAYER (GRAY) RCB-97108-O
SOLDER SIDE INNER LAYER (PINK) RCB-97109-O
OVERLAY ----- RCB-97111-O

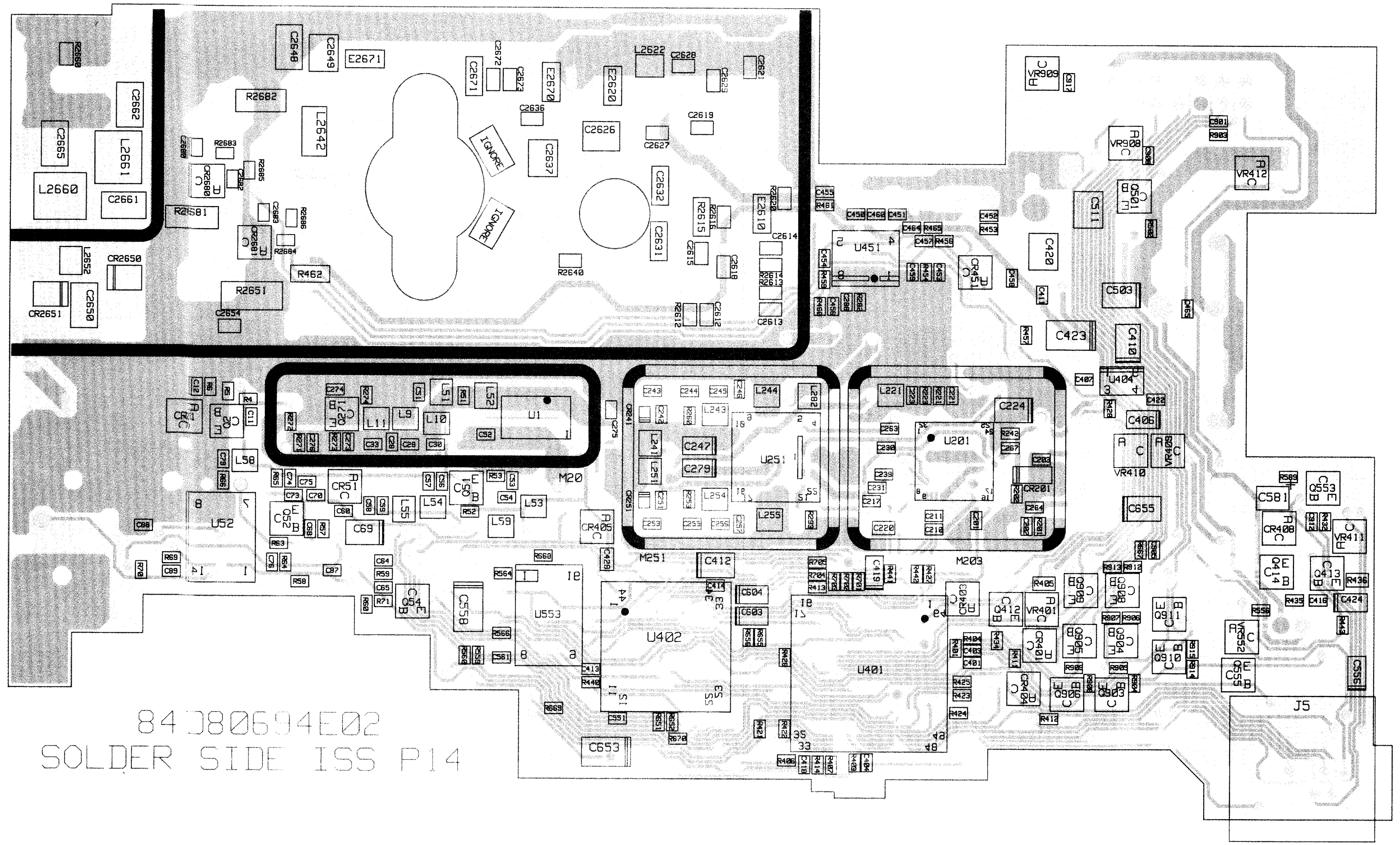
COMPONENT SIDE VIEW

Circuit Board Details for
UHF Main Boards, 450-474 MHz, 12.5 & 25 kHz, 25-40 W and 10-25 W
(Part of HUE3873C, HUE3579A, HUE3580A & HUE3871A Radios)



COMPONENT SIDE (GRAY) RCB-97107-O (REV)
SOLDER SIDE (PINK) RCB-97110-O (REV)
OVERLAY ----- RCB-97112-O

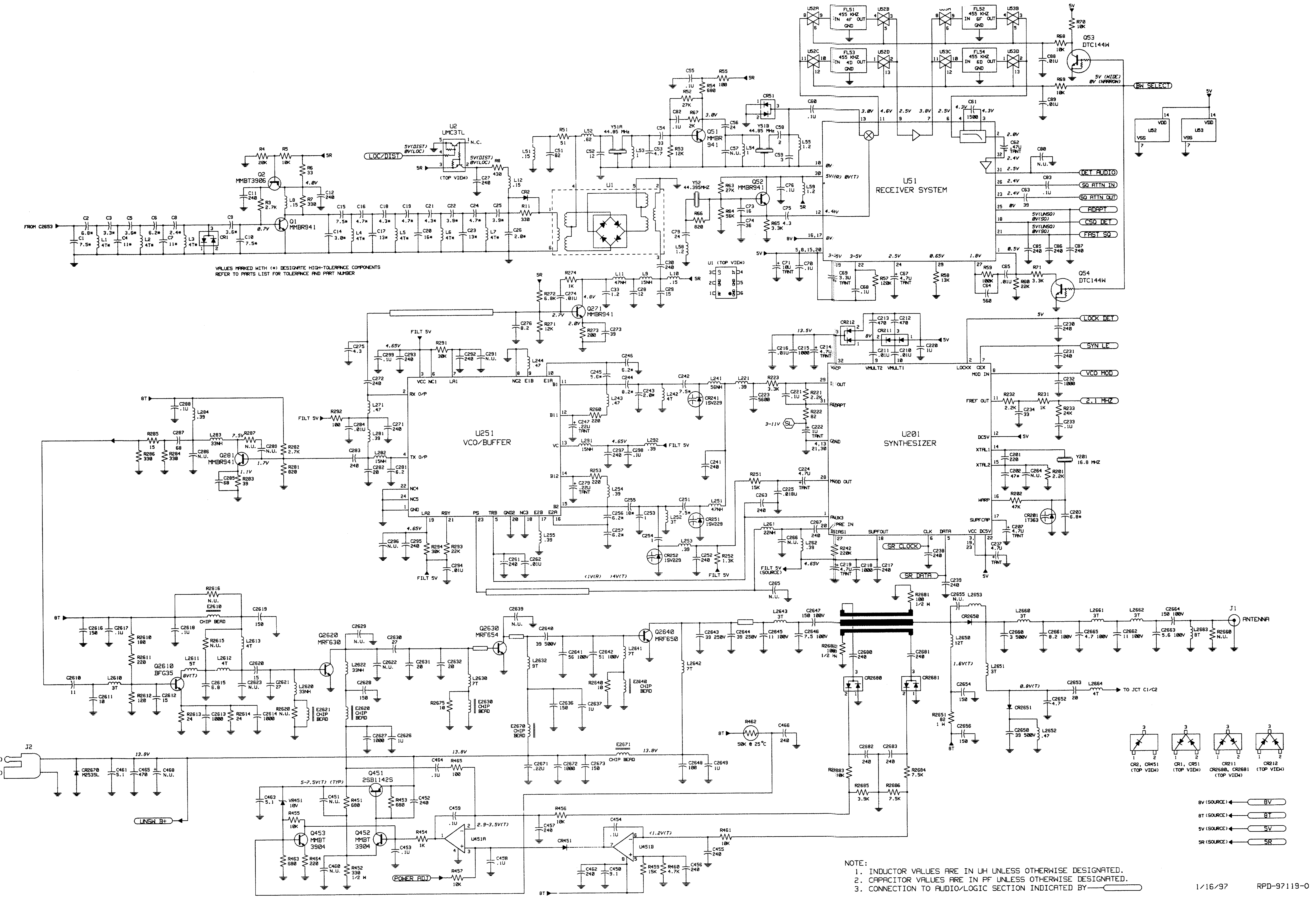
SOLDER SIDE VIEW



COMPONENT SIDE INNER LAYER (GRAY) RCB-97108-O (REV)
SOLDER SIDE INNER LAYER (PINK) RCB-97109-O (REV)
OVERLAY ----- RCB-97112-O

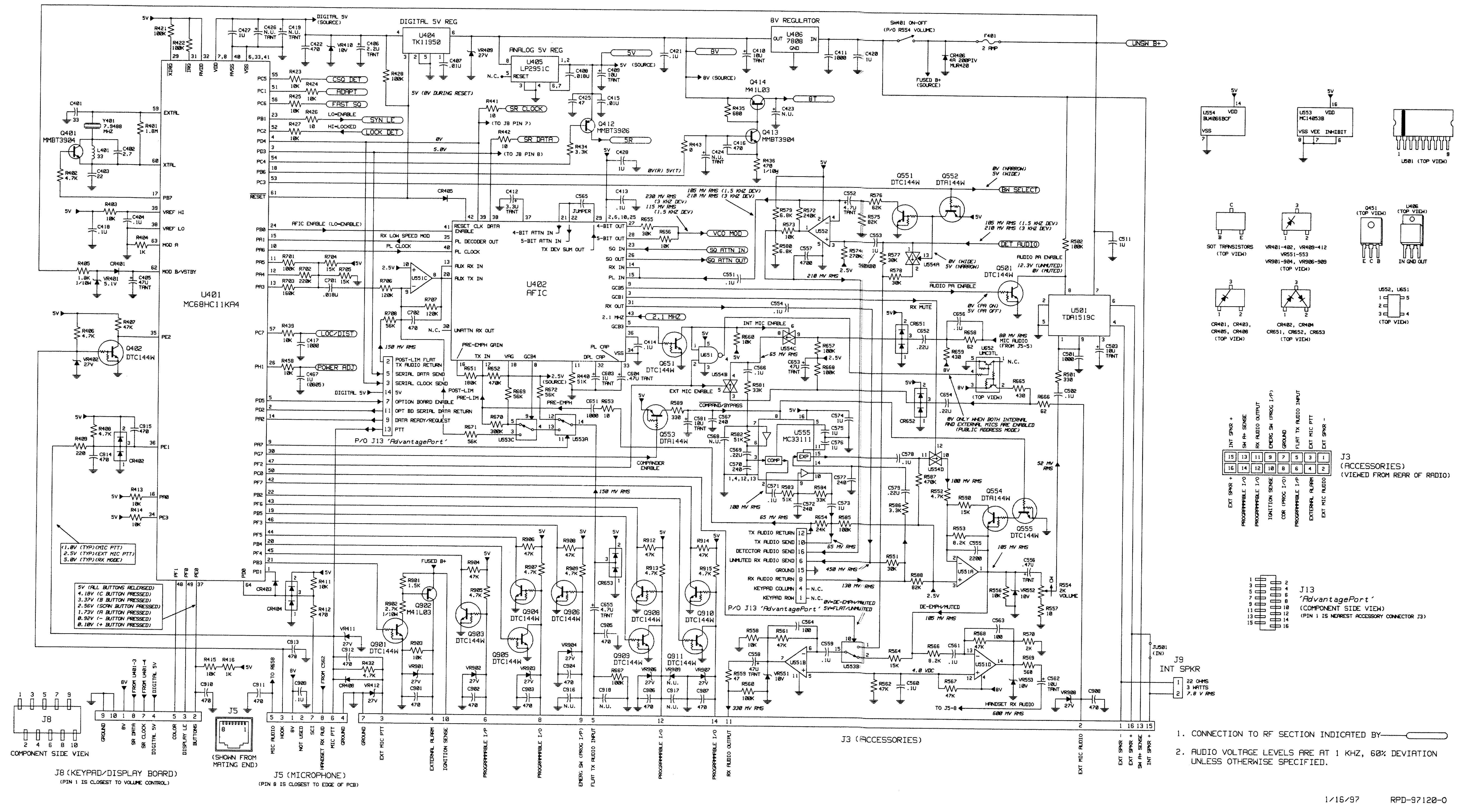
SOLDER SIDE VIEW

Circuit Board Details for
UHF Main Boards, 450-474 MHz, 12.5 & 25 kHz, 25-40 W and 10-25 W
(Part of HUE3873C, HUE3579A, HUE3580A & HUE3871A Radios)



NOTE:
1. INDUCTOR VALUES ARE IN UH UNLESS OTHERWISE DESIGNATED.
2. CAPACITOR VALUES ARE IN PF UNLESS OTHERWISE DESIGNATED.
3. CONNECTION TO AUDIO/LOGIC SECTION INDICATED BY

Schematic Diagram for
UHF Main Boards, 450-474 MHz, 12.5 & 25 kHz, 25-40 W
(Part of HUE3873C & HUE3579A Radios)
(Sheet 1 of 2)



Schematic Diagram for
UHF Main Boards, 450-474 MHz, 12.5 & 25 kHz, 25-40 W
(Part of HUE3873C & HUE3579A Radios)
(Sheet 2 of 2)

Parts List

HUE3873C, HUE3579A & HUE3545B UHF Radio, 450-474 MHz
12.5/25 kHz, 25-40 W PL-971002-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF +/-5%; 50 V:
		unless otherwise stated
C1	21-13740L15	7.5 ±0.1 pF
C2	21-13740L14	6.8 ±0.1 pF
C3	21-13740L06	3.3 ±0.1 pF
C4	21-13740L19	11 pF, 2%
C5	21-13740L07	3.6 ±0.1 pF
C6	21-13740L13	6.2 ±0.1 pF
C7	21-13740L19	11 pF, 2%
C8	21-13740L03	2.4 ±0.1 pF
C9	21-13740L07	3.6 ±0.1 pF
C10	21-13740L15	7.5 ±0.1 pF
C11, 12	21-13740F60	240 pF
C14	21-13740L05	3.0 ±0.1 pF
C15	21-13740L15	7.5 ±0.1 pF
C16	21-13740L10	4.7 ±0.1 pF
C17	21-13740L21	13 pF, 2%
C18	21-13740L09	4.3 ±0.1 pF
C19	21-13740L10	4.7 ±0.1 pF
C20	21-13740L23	16 pF, 2%
C21	21-13740L09	4.3 ±0.1 pF
C22	21-13740L08	3.9 ±0.1 pF
C23	21-13740L21	13 pF, 2%
C24	21-13740L10	4.7 ±0.1 pF
C25	21-13740L08	3.9 ±0.1 pF
C26	21-13740L01	2.0 ±0.1 pF
C27	21-13740F60	240 pF
C28	21-13740F29	12 pF
C29	21-13740F31	15 pF
C30	21-13740F60	240 pF
C33	21-13740F05	1.2 ±0.25 pF
C51	21-13740F49	82 pF
C52	21-13740F29	12 pF
C53	21-13740F19	4.7 ±0.25 pF
C54	21-13740F39	33 pF
C55	21-13743E20	0.1 uF, 10%; 16 V
C56	21-13740F36	24 pF
C57	---	Not Used
C58	21-13740F10	2 ±0.25 pF
C59	21-13740F14	3 ±0.25 pF
C60	21-13743E20	0.1 uF, 10%; 16 V
C61	21-13741F29	1500 pF
C62	23-11049A05	tantalum 0.47 uF, 10%; 25 V
C63	21-13740F41	39 pF
C64	21-13740F69	560 pF
C65	21-13741F49	.01 uF
C67	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C68	21-13743E20	0.1 uF, 10%; 16 V
C69	23-11049J07	tantalum 3.3 uF, 10%; 20 V
C70	21-13743E20	0.1 uF, 10% 16 V
C71	23-11049A57	tantalum 10 uF, 10%; 16 V
C73	21-13740F32	16 pF
C74	21-13740F40	36 pF
C75	21-13740F18	4.3 ±0.25 pF
C76	21-13743E20	0.1 uF, 10%; 16 V
C79	21-13740F36	24 pF
C80	---	Not Used
C82, 83	21-13743E20	0.1 uF, 10%; 16 V
C85 thru 87	21-13740F60	240 pF
C88, 89	21-13741F49	.01 uF
C201	21-13740F59	220 pF
C202	21-13740L34	47 pF, 2%
C203	21-13740L14	6.8 ±0.1 pF
C207	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C210, 211	21-13741F49	.01 uF
C212, 213	21-13741F17	470 pF
C214	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C215	21-13741F25	1000 pF
C216	21-13741F49	.01 uF
C217	21-13740F60	240 pF
C218	21-13741F25	1000 pF
C219	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C220	21-13928E01	1 uF, 10%; 10V
C221	21-13743E20	0.1 uF, 10%; 16V
C222	23-11049A07	tantalum 1 uF, 10%; 16 V
C223	21-13741F43	5600 pF
C224	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C225	21-13743E05	.018 uF, 10%; 16 V
C230, 231	21-13740F60	240 pF
C232	21-13741F25	1000 pF
C233	21-13743E20	0.1 uF, 10%; 16 V
C234	21-13740F39	33 pF

HUE3873C, HUE3579A & HUE3545B UHF Radio, 450-474 MHz
12.5/25 kHz, 25-40 W PL-971002-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C237	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C238 thru 241	21-13740F60	240 pF
C242	21-13740L15	7.5 ±0.1 pF
C243	21-13740L02	2.2 ±0.1 pF
C244	21-13740L16	8.2 ±0.1 pF
C245	21-13740L12	5.6 ±0.1 pF
C246	21-13740L13	6.2 ±0.1 pF
C247	23-11049A03	tantalum 0.22 uF, 10%; 35 V
C251	21-13740L15	7.5 ±0.1 pF
C252	21-13740F60	240 pF
C253, 254	21-13740F03	1 ±0.25 pF
C255	21-13740L24	18 pF, 2%
C256, 257	21-13740L13	6.2 ±0.1 pF
C261	21-13740F60	240 pF
C262	21-13741F49	.01 uF
C263	21-13740F60	240 pF
C264 thru 266	---	Not Used
C267	21-13740F60	240 pF
C271, 272	21-13740F60	240 pF
C273	21-13740F41	39 pF
C274	21-13741F49	.01 uF
C275	21-13740F18	4.3 ±0.25 pF
C276	21-13740F25	8.2 ±0.25 pF
C279	23-11049A03	tantalum 0.22 uF, 10%; 35 V
C281	21-13740F22	6.2 ±0.25 pF
C282	21-13740F34	20 pF
C283	21-13740F60	240 pF
C284	21-13741F49	.01 uF
C285	21-13740F47	68 pF
C286	---	Not Used
C287	21-13740F47	68 pF
C288	21-13743E20	0.1 uF, 10%; 16 V
C289	---	Not Used
C291	---	Not Used
C292, 293	21-13740F60	240 pF
C294	21-13741F49	.01 uF
C295	21-13740F60	240 pF
C296	---	Not Used
C297	21-13740F60	240 pF
C298, 299	21-13743E20	0.1 uF, 10%; 16 V
C401	21-13740F39	33 pF
C402	21-13740F13	2.7 ±0.25 pF
C403	21-13740F35	22 pF
C404	21-13743E20	0.1 uF, 10%; 16V
C405	23-11049J43	tantalum 47 uF, 10%; 10 V
C406	23-11049A40	tantalum 2.2 uF, 10%; 10 V
C407	21-13741F49	.01 uF
C408	21-13743E05	.018 uF, 10%; 16 V
C409, 410	23-11049A57	tantalum 10 uF, 10%; 16 V
C411	21-13741F25	1000 pF
C412	23-11049J07	tantalum 3.3 uF, 10%; 20 V
C413, 414	21-13743E20	0.1 uF, 10%; 16 V
C415	21-13741F49	.01 uF
C416	21-13741F17	470 pF
C417	21-13741F25	1000 pF
C418	21-13743E20	0.1 uF, 10%; 16 V
C419	---	Not Used
C420	21-13741W01	1 uF, 10%; 25 V
C421	21-13743E20	0.1 uF, 10%; 16 V
C422	21-13741F17	470 pF
C423, 424	---	Not Used
C425	21-13740F43	47 pF
C426	---	Not Used
C427, 428	21-13928E01	1 uF, 10%; 10 V
C450	21-13740F26	9.1 ±0.25 pF
C451	---	Not Used
C452	21-13740F60	240 pF
C453, 454	21-13743E20	0.1 uF, 10%; 16 V
C455 thru 457	21-13740F60	240 pF
C458, 459	21-13743E20	0.1 uF, 10%; 16 V
C460	---	Not Used
C461	21-13740F20	5.1 ±0.25 pF
C462	21-13740F60	240 pF
C463	21-13740F20	5.1 ±0.25 pF
C464	21-13743E20	0.1 uF, 10%; 16 V
C465	21-13741F17	470 pF
C466	21-13740F60	240 pF
C467	21-13928E01	1 uF, 10%; 10 V
C468	---	Not Used
C501	21-13741F25	1000 pF
C502	21-13743E20	0.1 uF, 10%; 16 V
C503	23-11049A57	tantalum 10 uF, 10%; 16 V

HUE3873C, HUE3579A & HUE3545B UHF Radio, 450-474 MHz
12.5/25 kHz, 25-40 W PL-971002-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C511	21-13741W01	1 uF, 10%; 25 V
C551	21-13743E20	0.1 uF, 10%; 16 V
C552	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C553	21-13928E01	1 uF, 10%; 10 V
C554	21-13743E20	0.1 uF, 10%; 16 V
C555	21-13741F33	2200 pF
C556	23-11049A05	tantalum 0.47 uF, 10%; 25 V
C557	21-13741F41	4700 pF
C558	23-11049J43	tantalum 47 uF, 10%; 10 V
C559 thru 561	21-13743E20	0.1 uF, 10%; 16 V
C562	23-11049A57	tantalum 10 uF, 10%; 16 V
C563, 564	21-13740F51	100 pF
C565	06-62057B47	jumper
C566	21-13743E20	0.1 uF, 10%; 16 V
C567	21-13740F60	240 pF
C568	---	Not Used
C569	21-13743K16	0.22 uF, +80/-20%; 16 V
C570	21-13740F60	240 pF
C571	21-13743E20	0.1 uF, 10%; 16 V
C572	21-13740F60	240 pF
C573 thru 576	21-13928E01	1 uF, 10%; 10 V
C577	21-13740F60	240 pF
C578	21-13743E20	0.1 uF, 10%; 16 V
C579	21-13743K16	0.22 uF, +80/-20%; 16 V
C581	23-11049A57	tantalum 10 uF, 10%; 16 V
C603	23-11049A07	tantalum 1 uF, 10%; 16 V
C604	23-11049A05	tantalum 0.47 uF, 10%; 25 V
C651	21-13741F25	1000 pF
C652	21-13743K16	0.22 uF, +80/-20%; 16 V
C653	23-11049J43	tantalum 47 uF, 10%; 10 V
C654	21-13743K16	0.22 uF, +80/-20%; 16 V
C655	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C656	21-13743E20	0.1 uF, 10%; 16 V
C701	21-13743E05	.018 uF, 10%; 16 V
C702	21-13741F17	470 pF
C901 thru 908	21-13741F17	470 pF
C909	21-13743E20	0.1 uF, 10%; 16 V
C910 thru 915	21-13741F17	470 pF
C916 thru 918	---	Not Used
C2610	21-13740A30	11 pF
C2611	21-13740A29	10 pF
C2612	21-13740A33	15 pF
C2613	21-13740A79	1000 pF
C2614	21-13740A79	1000 pF
C2615	21-13740A24	6.8 ±0.25 pF
C2616	21-13740A59	150 pF
C2617, 2618	21-13743A19	0.1 uF, 10%; 16 V
C2619	21-13740A59	150 pF
C2620	21-13740A33	15 pF
C2621	21-13740A39	27 pF
C2622, 2623	---	Not Used
C2626	21-13741W01	1 uF, 10%; 25 V
C2627	21-13740A79	1000 pF
C2628	21-13740A59	150 pF
C2629	---	Not Used
C2630	21-13740A39	27 pF
C2631, 2632	21-13740B32	20 pF
C2636	21-13740A59	150 pF
C2637	21-13741W01	1 uF, 10%; 25 V
C2639	---	Not Used
C2640	21-80060M33	39 pF; 500 V
C2641	21-11078B36	56 pF; 100 V
C2642	21-11078B35	51 pF; 100 V
C2643, 2644	21-80964X35	clamped mica 39 pF; 250 V
C2645	21-11078B14	11 pF; 100 V
C2646	21-11078B10	7.5 ±0.25 pF; 100 V
C2647	21-80060M47	150 pF; 100 V
C2648	21-13740B49	100 pF
C2649	21-13741W01	1 uF, 10%; 25 V
C2650	21-80060M33	39 pF; 500 V
C2652	21-13740F19	4.7 ±0.25 pF
C2653	21-13740F34	20 pF
C2654	21-13740A59	150 pF
C2655	---	Not Used
C2656	21-13740A59	150 pF
C2660	21-80060M05	3 ±0.5 pF; 500 V
C2661	21-11078B11	8.2 ±0.25 pF; 100 V
C2662	21-11078B14	11 pF; 100 V
C2663	21-11078B07	5.6 ±0.25 pF; 100 V
C2664	21-80060M47	150 pF; 100 V
C2665	21-11078B05	4.7 ±0.25 pF; 100 V
C2671	21-11032B15	0.22 uF, +80/-20%

HUE3873C, HUE3579A & HUE3545B UHF Radio, 450-474 MHz
12.5/25 kHz, 25-40 W PL-971002-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C2672	21-13740A79	1000 pF
C2673	21-13740A59	150 pF
C2680 thru 2683	21-13740F60	240 pF
		diode: (see note)
CR1	48-80154K03	dual Schottky SOT
CR2	48-80142L01	silicon PIN SOT MMBV3401
CR51	48-80154K03	dual Schottky SOT
CR201	48-02245J22	silicon varactor SOT 1T363
CR211	48-13833C07	dual silicon SOT MMBD7000
CR212	48-05218N57	dual silicon SOT
CR241	48-62824C01	silicon varactor SOT 1SV229
CR251, 252	48-62824C01	silicon varactor SOT 1SV229
CR401	48-05129M76	silicon SOT
CR402	48-13833C07	dual silicon SOT MMBD7000
CR403	48-80939T01	Schottky SOT
CR404	48-13833C07	dual silicon SOT MMBD7000
CR405	48-05129M76	silicon SOT
CR406	48-83553T02	4A 200 PIV MUR420
CR408	48-05129M76	silicon SOT
CR451	48-05129M76	silicon SOT
CR651 thru 653	48-13833C07	dual silicon SOT MMBD7000
CR2650, 2651	48-02482J02	silicon PIN MA4P1250
CR2670	48-80236E07	transient suppressor
CR2680, 2681	48-82290T02	dual Schottky SOT HSMS-2802
		ferrite beads:
E2610	24-84657R01	ferrite bead
E2620, 2621	24-84657R01	ferrite bead
E2630	24-84657R01	ferrite bead
E2640	24-84657R01	ferrite bead
E2670, 2671	24-84657R01	ferrite bead
		fuse:
F401	65-05214E04	2 amp axial lead
		filter:
FL51	91-80098D14	455 kHz 4F
FL52	91-80097D04	455 kHz 6F
FL53	91-80098D16	455 kHz 4D
FL54	91-80097D16	455 kHz 6D
		connector, receptacle:
J1	09-80476U01	mini UHF coax
J2	30-04510J01	power cable assembly (includes J2)
J3	28-04503J01	16-pin, accessories
J5	09-04426J01	telephone type, 8 contact, microphone
J8	09-04422J01	10-pin, display board
J9	28-04423J01	2-pin, internal speaker
J13	09-80472U01	16-pin, option board
		jumper:
JU501	06-62057B47	jumper
		coil, rf:
L1 thru 7	24-84562T11	4 turns airwound, 2%
L8	24-62587X55	chip 0.15 uH, 5%
L9	24-62587X43	chip 15 nH, 5%
L10	24-83411T63	0.15 uH, 5% shielded
L11	24-62587X49	chip 47 nH, 5%
L12	24-62587X55	chip 0.15 uH, 5%
L51	24-62587X55	chip 0.15 uH, 5%
L52	24-62587X63	chip 0.62 uH, 5%
L53, 55	24-62587X68	chip 1 uH, 5%
L55	24-62587X69	chip 1.2 uH, 5%
L58, 59	24-62587X69	chip 1.2 uH, 5%
L221	24-62587X60	chip 0.39 uH, 5%
L241	24-62587X50	chip 56 nH, 5%
L242	24-84562T11	4 turns airwound, 2%
L243, 244	24-62587X61	chip 0.47 uH, 5%
L251	24-62587X49	chip 47 nH, 5%
L252	24-84562T13	3 turns airwound, 2%
L253 thru 255	24-62587X60	chip 0.39 uH, 5%
L261	24-62587X45	chip 22 nH, 5%
L262	24-62587X60	chip 0.39 uH, 5%
L271	24-62587X61	chip 0.47 uH, 5%
L281	24-62587X60	chip 0.39 uH, 5%
L282	24-62587X43	chip 15 nH, 5%
L283	24-62587X47	chip 33 nH, 5%
L284	24-62587X60	chip 0.39 uH, 5%
L291	24-62587X43	chip 15 nH, 5%
L292	24-62587X60	chip 0.39 uH, 5%

HUE3873C, HUE3579A & HUE3545B UHF Radio, 450-474 MHz
12.5/25 kHz, 25-40 W PL-971002-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L401	24-60578C43	chip 33 uH
L2610	24-60591A01	3 turns
L2611	24-60591C73	5 turns
L2612	24-60591B17	4 turns
L2613	24-60591B73	4 turns
L2620	24-62587T40	chip 33 nH, 5%
L2622	24-62587T40	chip 33 nH, 5%
L2630	24-60591E73	7 turns
L2632	24-60591G73	9 turns
L2641	24-60591E73	7 turns
L2642	24-60591E69	7 turns
L2643	24-60591A33	3 turns
L2650	24-60591V77	12 turns
L2651	24-60591X01	3 turns
L2652	24-11087B22	chip 0.47 uH
L2653	---	Not Used
L2660 thru 2662	24-60591X01	3 turns
L2663	24-60591R53	8 turns
L2664	24-60591B77	4 turns
		transistor: (see note)
Q1	48-13827A07	NPN; type MMBR941
Q2	48-13824A17	PNP; type MMBT3906
Q51, 52	48-13827A07	NPN; type MMBR941
Q53, 54	48-80947V01	digital NPN; type DTC144W
Q271	48-13827A07	NPN; type MMBR941
Q281	48-13827A07	NPN; type MMBR941
Q401	48-80214G02	NPN; type MMBT3904
Q402	48-80947V01	digital NPN; type DTC144W
Q412	48-13824A17	PNP; type MMBT3906
Q413	48-80214G02	NPN; type MMBT3904
Q414	48-80141L03	PNP; type BCW68G
Q451	48-02245J25	PNP; type 2SB1142S
Q452, 453	48-80214G02	NPN; type MMBT3904
Q501	48-80947V01	digital NPN; type DTC144W
Q551	48-80947V01	digital NPN; type DTC144W
Q552 thru 554	48-80494U01	digital PNP; type DTA144W
Q555	48-80947V01	digital NPN; type DTC144W
Q651	48-80947V01	digital NPN; type DTC144W
Q901	48-80947V01	digital NPN; type DTC144W
Q902	48-80141L03	PNP; type BCW68G
Q903 thru 906	48-80947V01	digital NPN; type DTC144W
Q908 thru 911	48-80947V01	digital NPN; type DTC144W
Q2610	48-02245J24	NPN; type BFG35
Q2620	48-80225C09	NPN; type MRF630
Q2630	48-80225C19	NPN; type MRF654
Q2640	48-80225C24	NPN; type MRF650
		resistor, fixed: +/-5%; 1/16 W:
		unless otherwise stated
R3	06-62057A59	2.7k
R4	06-62057A80	20k
R5	06-62057A73	10k
R6	06-62057A13	33
R7	06-62057A37	330
R8	06-62057A40	430
R11	06-62057C63	330; 1/10 watt
R51	06-62057A18	51
R52	06-62057A83	27k
R53	06-62057A75	12k
R54	06-62057A45	680
R55	06-62057A25	100
R57	06-62057A99	120k
R58	06-62057A76	13k
R59	06-62057A97	100k
R60	06-62057A81	22k
R63	06-62057A83	27k
R64	06-62057A91	56k
R65	06-62057A61	3.3k
R66	06-62057A47	820
R67	06-62057A56	2k
R68 thru 70	06-62057A73	10k
R71	06-62057A61	3.3k
R201	06-62057A57	2.2k
R202	06-62057A89	47k
R221	06-62057A57	2.2k
R222	06-62057A23	82
R223	06-62057A61	3.3k
R231	06-62057A49	1k
R232	06-62057A57	2.2k
R233	06-62057A82	24k
R242	06-62057B06	220k

HUE3873C, HUE3579A & HUE3545B UHF Radio, 450-474 MHz
12.5/25 kHz, 25-40 W PL-971002-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R251	06-62057A77	15k
R252	06-62057A52	1.3k
R253	06-62057A33	220
R260	06-62057A33	220
R271	06-62057A75	12k
R272	06-62057A69	6.8k
R273	06-62057A32	200
R274	06-62057A49	1k
R281	06-62057A47	820
R282	06-62057A59	2.7k
R283	06-62057A15	39
R284	06-62057A37	330
R285	06-62057A05	15
R286	06-62057A37	330
R287	---	Not Used
R291	06-62057A84	30k
R292	06-62057A25	100
R293	06-62057A81	22k
R294	06-62057A84	30k
R401	06-62057B28	1.8 meg
R402	06-62057A65	4.7k
R403	06-62057A73	10k
R404	06-62057A49	1k
R405	06-62057C81	1.8k; 1/10 watt
R406	06-62057A65	4.7k
R407	06-62057A89	47k
R408	06-62057A65	4.7k
R409	06-62057A33	220
R411	06-62057A73	10k
R412	06-62057A41	470
R413 thru 415	06-62057A73	10k
R416	06-62057A49	1k
R421, 422	06-62057A97	100k
R423 thru 425	06-62057A73	10k
R426	06-62057A01	10
R427	06-62057A73	10k
R428	06-62057A97	100k
R432	06-62057A65	4.7k
R434	06-62057A61	3.3k
R435	06-62057A45	680
R436	06-62057C67	470; 1/10 watt
R439	06-62057A73	10k
R440	06-62057A90	51k
R441, 442	06-62057A01	10
R443	06-62057B47	0
R451	06-62057A45	680
R452	06-80195M37	330; 1/2 watt
R453	06-62057A45	680
R454	06-62057A49	1k
R455 thru 458	06-62057A73	10k
R459	06-62057A77	15k
R460	06-62057A65	4.7k
R461	06-62057A73	10k
R462	06-05621T02	thermistor 50k @ 25 degrees C
R463	06-62057A45	680
R464	06-62057A33	220
R465	06-62057A25	100
R501	06-62057A37	330
R502	06-62057A97	100k
R551	06-62057A84	30k
R552	06-62057A65	4.7k
R553	06-62057A71	8.2k
R554	18-04405J02	variable 2k with switch
R556	06-62057A73	10k
R557	06-62057A01	10
R558	06-62057A73	10k
R559	06-62057A17	47
R560	06-62057A97	100k
R561, 562	06-62057A89	47k
R564	06-62057A77	15k
R566	06-62057A71	8.2k
R567, 568	06-62057A89	47k
R569	06-62057A43	560
R570	06-62057A56	2k
R572	06-62057B07	240k
R573	06-62057A73	10k
R574	06-62057B08	270k
R575	06-62057A95	82k
R576	06-62057A92	62k
R577, 578	06-62057A84	30k
R579, 580	06-62057A69	6.8k
R581	06-62057A85	33k

HUE3873C, HUE3579A & HUE3545B UHF Radio, 450-474 MHz
12.5/25 kHz, 25-40 W PL-971002-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R582, 583	06-62057A90	51k
R584	06-62057A85	33k
R585	06-62057A97	100k
R586	06-62057A61	3.3k
R587	06-62057B14	470k
R588	06-62057A95	82k
R589	06-62057A37	330
R590	06-62057A77	15k
R651	06-62057B04	180k
R652	06-62057B14	470k
R653	06-62057A01	10
R654	06-62057A82	24k
R655	06-62057A84	30k
R656	06-62057A73	10k
R657	06-62057A97	100k
R658	06-62057A20	62
R659	06-62057A40	430
R660	06-62057A73	10k
R665	06-62057A40	430
R666	06-62057A20	62
R667, 668	06-62057A97	100k
R669	06-62057A91	56k
R670	06-62057B09	300k
R671, 672	06-62057A91	56k
R701	06-62057A97	100k
R702	06-62057B06	220k
R703	06-62057B03	160k
R704, 705	06-62057A77	15k
R706, 707	06-62057A99	120k
R708	06-62057A91	56k
R901	06-62057A53	1.5k
R902	06-62057C85	2.7k; 1/10 watt
R903	06-62057A73	10k
R904	06-62057A89	47k
R905	06-62057A65	4.7k
R906	06-62057A89	47k
R907	06-62057A65	4.7k
R908	06-62057A89	47k
R909	06-62057A65	4.7k
R912	06-62057A89	47k
R913	06-62057A65	4.7k
R914	06-62057A89	47k
R915	06-62057A65	4.7k
R2610	06-62057C57	180; 1/10 watt
R2611	06-62057C59	220; 1/10 watt
R2612	06-62057C53	120 ;1/10 watt
R2613, 614	06-62057C36	24; 1/10 watt
R2615, 2616	---	Not Used
R2620	---	Not Used
R2640	06-62057C27	10; 1/10 watt
R2651	06-80194M23	82; 1 watt
R2660		Not Used
R2675	06-62057C27	10; 1/10 watt
R2681, 2682	06-80195M25	100; 1/2 watt
R2683, 2684	06-62057A73	10k
R2685, 2686	06-62057A63	3.9k
		integrated circuit: (see note)
U1	51-80505D05	double-balanced mixer
U2	48-09939C04	dual transistor switch UMC3TL
U51	51-80605E02	receiver system
U52	51-05663U35	quad analog switch 4066B
U53	51-05663U35	quad analog switch 4066B
U201*		synthesizer
U251	51-05414S84	VCO/buffer
U401*		microcomputer MC68HC11KA4
U402	51-80604E01	audio filter
U404	51-80633C01	5 V regulator TK11950
U405	51-05469E65	5 V regulator LP2951C
U406	51-13816D03	8 V regulator MC7808BT
U451	51-80932W01	dual op-amp LM2904 SOIC
U501	51-80147R01	audio power amp TDA1519C
U551	51-02198J28	quad op-amp LM2902D SOIC
U552	51-62852A09	single opamp LMC7101
U553	51-84704M60	triple 2-channel switch 4053B
U554	51-05663U35	quad analog switch 4066B
U555	51-13811A35	compander MC33111
U651	51-05461G61	NAND gate TC7S00F
U652	48-09939C04	dual transistor switch UMC3TL
		voltage regulator: (see note)
VR401	48-80140L06	zener diode 5.1 V SOT

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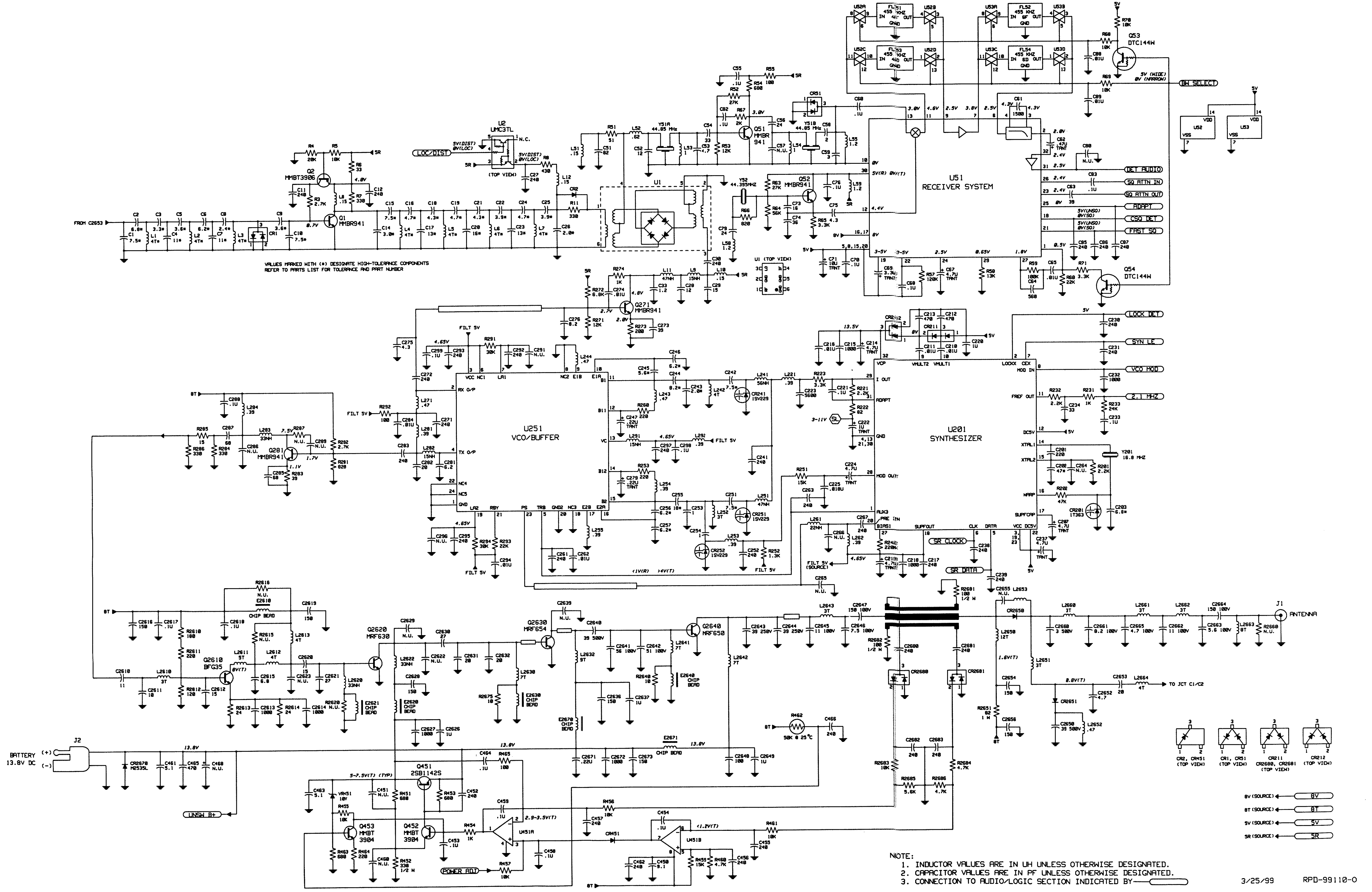
HUE3873C, HUE3579A & HUE3545B UHF Radio, 450-474 MHz
12.5/25 kHz, 25-40 W PL-971002-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
VR402	48-80948V01	zener diode 27 V SOT
VR409	48-80948V01	zener diode 27 V SOT
VR410	48-80140L15	zener diode 10 V SOT
VR411, 412	48-80948V01	zener diode 27 V SOT
VR451	48-80140L15	zener diode 10 V SOT
VR551 thru 553	48-80140L15	zener diode 10 V SOT
VR901 thru 904	48-80948V01	zener diode 27 V SOT
VR906 thru 909	48-80948V01	zener diode 27 V SOT
		crystal: (see note)
Y51	91-80112R13	filter 44.85 MHz
		(includes Y51A and Y51B)
Y52	48-80606B07	44.395 MHz
Y201*		16.8 MHz
Y401	48-80113R01	7.9488 MHz
	non-referenced items	
	14-05160A02	crystal insulator (for Y201)
	26-04398J01	VCO/synthesizer shield (4 used)
	26-04399J01	receiver mixer bottom shield
	26-04400J01	receiver front end top shield
	26-04419J01	PA shield frame
	26-04420J01	PA shield cover
	26-80481U01	TX buffer top shield
	42-80281L01	ground clip (2 used for Q2640)

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

Designators marked with an (*) denote parts which are not field serviceable. Recalibration of the radio using specialized factory equipment is mandatory when these components are replaced in order to guarantee the specified frequency stability of the radio at temperature extremes.

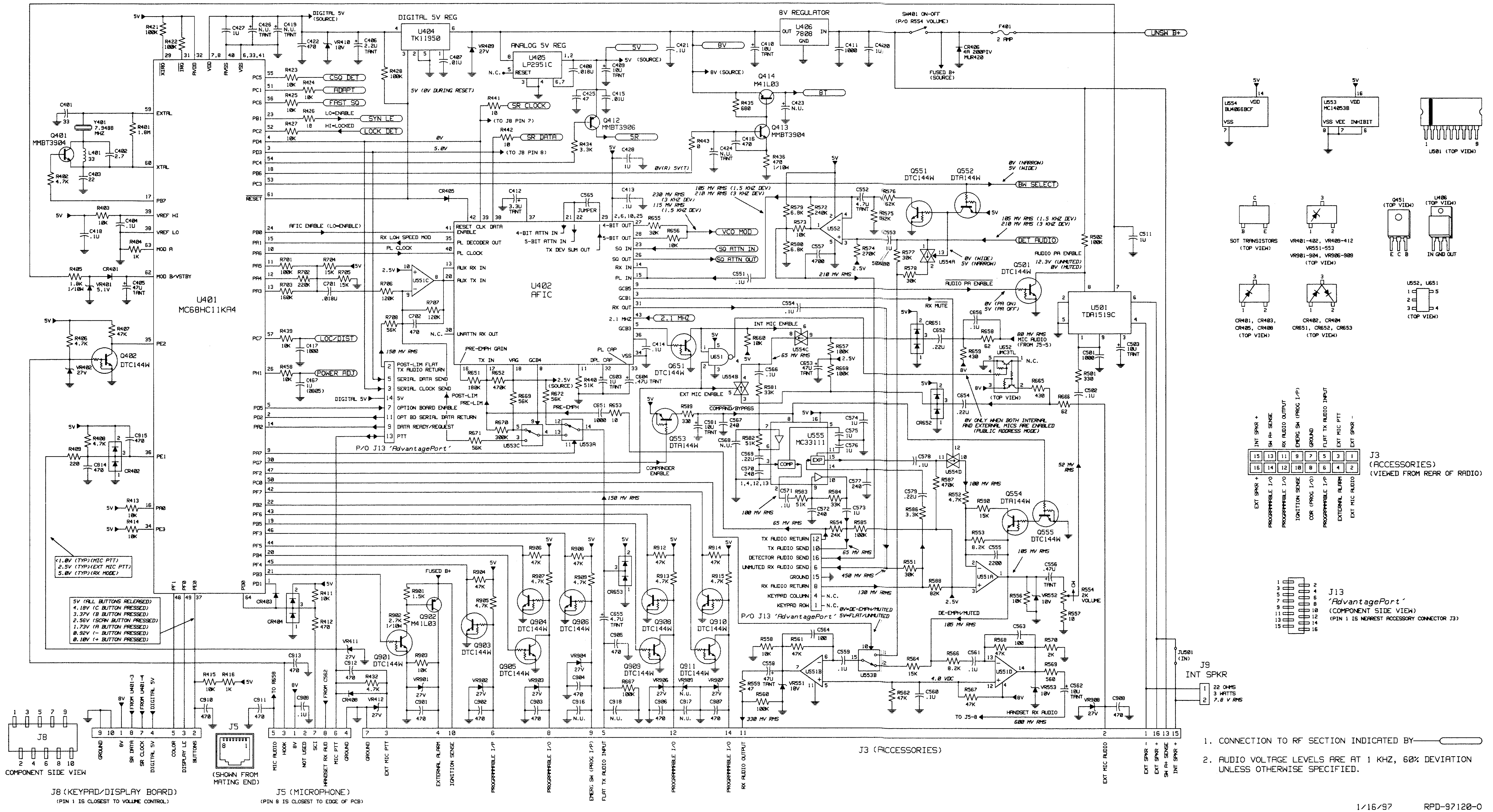
Parts List for
UHF Main Boards, 450-474 MHz, 12.5 & 25 kHz, 25-40 W
(Part of HUE3873C & HUE3579A Radios)



NOTE:
1. INDUCTOR VALUES ARE IN UH UNLESS OTHERWISE DESIGNATED.
2. CAPACITOR VALUES ARE IN PF UNLESS OTHERWISE DESIGNATED.
3. CONNECTION TO AUDIO/LOGIC SECTION INDICATED BY

3/25/99 RPD-99110-O

Schematic Diagram for
UHF Main Boards, 450-474 MHz, 12.5 & 25 kHz, 10-25 W
(Part of HUE3871A & HUE3580A Radios)
(Sheet 1 of 2)



1. CONNECTION TO RF SECTION INDICATED BY
2. AUDIO VOLTAGE LEVELS ARE AT 1 KHZ, 60% DEVIATION UNLESS OTHERWISE SPECIFIED.

Schematic Diagram for UHF Main Boards, 450-474 MHz, 12.5 & 25 kHz, 10-25 W (Part of HUE3871A & HUE3580A Radios) (Sheet 2 of 2)

Parts List

HUE3871A & HUE3580A UHF Radio, 450-474 MHz
12.5/25 kHz, 10-25 W PL-991005-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF +/-5%; 50 V:
		unless otherwise stated
C1	21-13740L15	7.5 ±0.1 pF
C2	21-13740L14	6.8 ±0.1 pF
C3	21-13740L06	3.3 ±0.1 pF
C4	21-13740L19	11 pF, 2%
C5	21-13740L07	3.6 ±0.1 pF
C6	21-13740L13	6.2 ±0.1 pF
C7	21-13740L19	11 pF, 2%
C8	21-13740L03	2.4 ±0.1 pF
C9	21-13740L07	3.6 ±0.1 pF
C10	21-13740L15	7.5 ±0.1 pF
C11, 12	21-13740F60	240 pF
C14	21-13740L05	3.0 ±0.1 pF
C15	21-13740L15	7.5 ±0.1 pF
C16	21-13740L10	4.7 ±0.1 pF
C17	21-13740L21	13 pF, 2%
C18	21-13740L09	4.3 ±0.1 pF
C19	21-13740L10	4.7 ±0.1 pF
C20	21-13740L23	16 pF, 2%
C21	21-13740L09	4.3 ±0.1 pF
C22	21-13740L08	3.9 ±0.1 pF
C23	21-13740L21	13 pF, 2%
C24	21-13740L10	4.7 ±0.1 pF
C25	21-13740L08	3.9 ±0.1 pF
C26	21-13740L01	2.0 ±0.1 pF
C27	21-13740F60	240 pF
C28	21-13740F29	12 pF
C29	21-13740F31	15 pF
C30	21-13740F60	240 pF
C33	21-13740F05	1.2 ±0.25 pF
C51	21-13740F49	82 pF
C52	21-13740F29	12 pF
C53	21-13740F19	4.7 ±0.25 pF
C54	21-13740F39	33 pF
C55	21-13743E20	0.1 uF, 10%; 16 V
C56	21-13740F36	24 pF
C57	---	Not Used
C58	21-13740F10	2 ±0.25 pF
C59	21-13740F14	3 ±0.25 pF
C60	21-13743E20	0.1 uF, 10%; 16 V
C61	21-13741F29	1500 pF
C62	23-11049A05	tantalum 0.47 uF, 10%; 25 V
C63	21-13740F41	39 pF
C64	21-13740F69	560 pF
C65	21-13741F49	.01 uF
C67	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C68	21-13743E20	0.1 uF, 10%; 16 V
C69	23-11049J07	tantalum 3.3 uF, 10%; 20 V
C70	21-13743E20	0.1 uF, 10% 16 V
C71	23-11049A57	tantalum 10 uF, 10%; 16 V
C73	21-13740F32	16 pF
C74	21-13740F40	36 pF
C75	21-13740F18	4.3 ±0.25 pF
C76	21-13743E20	0.1 uF, 10%; 16 V
C79	21-13740F36	24 pF
C80	---	Not Used
C82, 83	21-13743E20	0.1 uF, 10%; 16 V
C85 thru 87	21-13740F60	240 pF
C88, 89	21-13741F49	.01 uF
C201	21-13740F59	220 pF
C202	21-13740L34	47 pF, 2%
C203	21-13740L14	6.8 ±0.1 pF
C207	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C210, 211	21-13741F49	.01 uF
C212, 213	21-13741F17	470 pF
C214	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C215	21-13741F25	1000 pF
C216	21-13741F49	.01 uF
C217	21-13740F60	240 pF
C218	21-13741F25	1000 pF
C219	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C220	21-13928E01	1 uF, 10%; 10V
C221	21-13743E20	0.1 uF, 10%; 16V
C222	23-11049A07	tantalum 1 uF, 10%; 16 V
C223	21-13741F43	5600 pF
C224	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C225	21-13743E05	.018 uF, 10%; 16 V
C230, 231	21-13740F60	240 pF
C232	21-13741F25	1000 pF
C233	21-13743E20	0.1 uF, 10%; 16 V
C234	21-13740F39	33 pF
C237	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C238 thru 241	21-13740F60	240 pF
C242	21-13740L15	7.5 ±0.1 pF
C243	21-13740L02	2.2 ±0.1 pF
C244	21-13740L16	8.2 ±0.1 pF
C245	21-13740L12	5.6 ±0.1 pF
C246	21-13740L13	6.2 ±0.1 pF
C247	23-11049A03	tantalum 0.22 uF, 10%; 35 V
C251	21-13740L15	7.5 ±0.1 pF
C252	21-13740F60	240 pF
C253, 254	21-13740F03	1 ±0.25 pF
C255	21-13740L24	18 pF, 2%
C256, 257	21-13740L13	6.2 ±0.1 pF
C261	21-13740F60	240 pF
C262	21-13741F49	.01 uF
C263	21-13740F60	240 pF
C264 thru 266	---	Not Used
C267	21-13740F60	240 pF
C271, 272	21-13740F60	240 pF
C273	21-13740F41	39 pF
C274	21-13741F49	.01 uF
C275	21-13740F18	4.3 ±0.25 pF
C276	21-13740F25	8.2 ±0.25 pF
C279	23-11049A03	tantalum 0.22 uF, 10%; 35 V
C281	21-13740F22	6.2 ±0.25 pF
C282	21-13740F34	20 pF
C283	21-13740F60	240 pF
C284	21-13741F49	.01 uF
C285	21-13740F47	68 pF
C286	---	Not Used
C287	21-13740F47	68 pF
C288	21-13743E20	0.1 uF, 10%; 16 V
C289	---	Not Used
C291	---	Not Used
C292, 293	21-13740F60	240 pF
C294	21-13741F49	.01 uF
C295	21-13740F60	240 pF
C296	---	Not Used
C297	21-13740F60	240 pF
C298, 299	21-13743E20	0.1 uF, 10%; 16 V
C401	21-13740F39	33 pF
C402	21-13740F13	2.7 ±0.25 pF
C403	21-13740F35	22 pF
C404	21-13743E20	0.1 uF, 10%; 16V
C405	23-11049J43	tantalum 47 uF, 10%; 10 V
C406	23-11049A40	tantalum 2.2 uF, 10%; 10 V
C407	21-13741F49	.01 uF
C408	21-13743E05	.018 uF, 10%; 16 V
C409, 410	23-11049A57	tantalum 10 uF, 10%; 16 V
C411	21-13741F25	1000 pF
C412	23-11049J07	tantalum 3.3 uF, 10%; 20 V
C413, 414	21-13743E20	0.1 uF, 10%; 16 V
C415	21-13741F49	.01 uF
C416	21-13741F17	470 pF
C417	21-13741F25	1000 pF
C418	21-13743E20	0.1 uF, 10%; 16 V
C419	---	Not Used
C420	21-13741W01	1 uF, 10%; 25 V
C421	21-13743E20	0.1 uF, 10%; 16 V
C422	21-13741F17	470 pF
C423, 424	---	Not Used
C425	21-13740F43	47 pF
C426	---	Not Used
C427, 428	21-13928E01	1 uF, 10%; 10 V
C450	21-13740F26	9.1 ±0.25 pF
C451	---	Not Used
C452	21-13740F60	240 pF
C453, 454	21-13743E20	0.1 uF, 10%; 16 V
C455 thru 457	21-13740F60	240 pF
C458, 459	21-13743E20	0.1 uF, 10%; 16 V
C460	---	Not Used
C461	21-13740F20	5.1 ±0.25 pF
C462	21-13740F60	240 pF
C463	21-13740F20	5.1 ±0.25 pF
C464	21-13743E20	0.1 uF, 10%; 16 V
C465	21-13741F17	470 pF
C466	21-13740F60	240 pF
C467	21-13928E01	1 uF, 10%; 10 V
C468	---	Not Used
C501	21-13741F25	1000 pF
C502	21-13743E20	0.1 uF, 10%; 16 V
C503	23-11049A57	tantalum 10 uF, 10%; 16 V
C511	21-13741W01	1 uF, 10%; 25 V
C551	21-13743E20	0.1 uF, 10%; 16 V
C552	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C553	21-13928E01	1 uF, 10%; 10 V
C554	21-13743E20	0.1 uF, 10%; 16 V
C555	21-13741F33	2200 pF
C556	23-11049A05	tantalum 0.47 uF, 10%; 25 V
C557	21-13741F41	4700 pF
C558	23-11049J43	tantalum 47 uF, 10%; 10 V
C559 thru 561	21-13743E20	0.1 uF, 10%; 16 V
C562	23-11049A57	tantalum 10 uF, 10%; 16 V
C563, 564	21-13740F51	100 pF
C565	06-62057B47	jumper
C566	21-13743E20	0.1 uF, 10%; 16 V
C567	21-13740F60	240 pF
C568	---	Not Used
C569	21-13743K16	0.22 uF, +80/-20%; 16 V
C570	21-13740F60	240 pF
C571	21-13743E20	0.1 uF, 10%; 16 V
C572	21-13740F60	240 pF
C573 thru 576	21-13928E01	1 uF, 10%; 10 V
C577	21-13740F60	240 pF
C578	21-13743E20	0.1 uF, 10%; 16 V
C579	21-13743K16	0.22 uF, +80/-20%; 16 V
C581	23-11049A57	tantalum 10 uF, 10%; 16 V
C603	23-11049A07	tantalum 1 uF, 10%; 16 V
C604	23-11049A05	tantalum 0.47 uF, 10%; 25 V
C651	21-13741F25	1000 pF
C652	21-13743K16	0.22 uF, +80/-20%; 16 V
C653	23-11049J43	tantalum 47 uF, 10%; 10 V
C654	21-13743K16	0.22 uF, +80/-20%; 16 V
C655	23-11049J11	tantalum 4.7 uF, 10%; 16 V
C656	21-13743E20	0.1 uF, 10%; 16 V
C701	21-13743E05	.018 uF, 10%; 16 V
C702	21-13741F17	470 pF
C901 thru 908	21-13741F17	470 pF
C909	21-13743E20	0.1 uF, 10%; 16 V
C910 thru 915	21-13741F17	470 pF
C916 thru 918	---	Not Used
C2610	21-13740A30	11 pF
C2611	21-13740A29	10 pF
C2612	21-13740A33	15 pF
C2613	21-13740A79	1000 pF
C2614	21-13740A79	1000 pF
C2615	21-13740A24	6.8 ±0.25 pF
C2616	21-13740A59	150 pF
C2617, 2618	21-13743A19	0.1 uF, 10%; 16 V
C2619	21-13740A59	150 pF
C2620	21-13740A33	15 pF
C2621	21-13740A39	27 pF
C2622, 2623	---	Not Used
C2626	21-13741W01	1 uF, 10%; 25 V
C2627	21-13740A79	1000 pF
C2628	21-13740A59	150 pF
C2629	---	Not Used
C2630	21-13740A39	27 pF
C2631, 2632	21-13740B32	20 pF
C2636	21-13740A59	150 pF
C2637	21-13741W01	1 uF, 10%; 25 V
C2639	---	Not Used
C2640	21-80060M33	39 pF; 500 V
C2641	21-11078B36	56 pF; 100 V
C2642	21-11078B35	51 pF; 100 V
C2643, 2644	21-80964X35	clamped mica 39 pF; 250 V
C2645	21-11078B14	11 pF; 100 V
C2646	21-11078B10	7.5 ±0.25 pF; 100 V
C2647	21-80060M47	150 pF; 100 V
C2648	21-13740B49	100 pF
C2649	21-13741W01	1 uF, 10%; 25 V
C2650	21-80060M33	39 pF; 500 V
C2652	21-13740F19	4.7 ±0.25 pF
C2653	21-13740F34	20 pF
C2654	21-13740A59	150 pF
C2655	---	Not Used
C2656	21-13740A59	150 pF
C2660	21-80060M05	3 ±0.5 pF; 500 V
C2661	21-11078B11	8.2 ±0.25 pF; 100 V
C2662	21-11078B14	11 pF; 100 V
C2663	21-11078B07	5.6 ±0.25 pF; 100 V
C2664	21-80060M47	150 pF; 100 V
C2665	21-11078B05	4.7 ±0.25 pF; 100 V
C2671	21-11032B15	0.22 uF, +80/-20%
C2672	21-13740A79	1000 pF
C2673	21-13740A59	150 pF
C2680 thru 2683	21-13740F60	240 pF
		diode: (see note)
CR1	48-80154K03	dual Schottky SOT
CR2	48-80142L01	silicon PIN SOT MMBV3401
CR51	48-80154K03	dual Schottky SOT
CR201	48-02245J22	silicon varactor SOT 1T363
CR211	48-13833C07	dual silicon SOT MMBD7000
CR212	48-05218N57	dual silicon SOT
CR241	48-62824C01	silicon varactor SOT 1SV229
CR251, 252	48-62824C01	silicon varactor SOT 1SV229
CR401	48-05129M76	silicon SOT
CR402	48-13833C07	dual silicon SOT MMBD7000
CR403	48-80939T01	Schottky SOT
CR404	48-13833C07	dual silicon SOT MMBD7000
CR405	48-05129M76	silicon SOT
CR406	48-83553T02	4A 200 PIV MUR420
CR408	48-05129M76	silicon SOT
CR451	48-05129M76	silicon SOT
CR651 thru 653	48-13833C07	dual silicon SOT MMBD7000
CR2650, 2651	48-02482J02	silicon PIN MA4P1250
CR2670	48-80236E07	transient suppressor
CR2680, 2681	48-82290T02	dual Schottky SOT HSMS-2802
		ferrite beads:
E2610	24-84657R01	ferrite bead
E2620, 2621	24-84657R01	ferrite bead
E2630	24-84657R01	ferrite bead
E2640	24-84657R01	ferrite bead
E2670, 2671	24-84657R01	ferrite bead
		fuse:
F401	65-05214E04	2 amp axial lead
		filter:
FL51	91-80098D14	455 kHz 4F
FL52	91-80097D04	455 kHz 6F
FL53	91-80098D16	455 kHz 4D
FL54	91-80097D16	455 kHz 6D
		connector, receptacle:
J1	09-80476U01	mini UHF coax
J2	30-04510J01	power cable assembly (includes J2)
J3	28-04503J01	16-pin, accessories
J5	09-04426J01	telephone type, 8 contact, microphone
J8	09-04422J01	10-pin, display board
J9	28-04423J01	2-pin, internal speaker
J13	09-80472U01	16-pin, option board
		jumper:
JU501	06-62057B47	jumper
		coil, rf:
L1 thru 7	24-84562T11	4 turns airwound, 2%
L8	24-62587X55	chip 0.15 uH, 5%
L9	24-62587X43	chip 15 nH, 5%
L10	24-83411T63	0.15 uH, 5% shielded
L11	24-62587X49	chip 47 nH, 5%
L12	24-62587X55	chip 0.15 uH, 5%
L51	24-62587X55	chip 0.15 uH, 5%
L52	24-62587X63	chip 0.62 uH, 5%
L53, 55	24-62587X68	chip 1 uH, 5%
L55	24-62587X69	chip 1.2 uH, 5%
L58, 59	24-62587X69	chip 1.2 uH, 5%
L221	24-62587X60	chip 0.39 uH, 5%
L241	24-62587X50	chip 56 nH, 5%
L242	24-84562T11	4 turns airwound, 2%
L243, 244	24-62587X61	chip 0.47 uH, 5%
L251	24-62587X49	chip 47 nH, 5%
L252	24-84562T13	3 turns airwound, 2%
L253 thru 255	24-62587X60	chip 0.39 uH, 5%
L261	24-62587X45	chip 22 nH, 5%
L262	24-62587X60	chip 0.39 uH, 5%
L271	24-62587X61	chip 0.47 uH, 5%
L281	24-62587X60	chip 0.39 uH, 5%
L282	24-62587X43	chip 15 nH, 5%
L283	24-62587X47	chip 33 nH, 5%
L284	24-62587X60	chip 0.39 uH, 5%
L291	24-62587X43	chip 15 nH, 5%
L292	24-62587X60	chip 0.39 uH, 5%
L401	24-60578C43	chip 33 uH
L2610	24-60591A01	3 turns
L2611	24-60591C73	5 turns
L2612	24-60591B17	4 turns
L2613	24-60591B73	4 turns
L2620	24-62587T40	chip 33 nH, 5%
L2622	24-62587T40	chip 33 nH, 5%
L2630	24-60591E73	7 turns
L2632	24-60591G73	9 turns
L2641	24-60591E73	7 turns
L2642	24-60591E69	7 turns
L2643	24-60591A33	3 turns
L2650	24-60591V77	12 turns
L2651	24-60591X01	3 turns
L2652	24-11087B22	chip 0.47 uH
L2653	---	Not Used
L2660 thru 2662	24-60591X01	3 turns
L2663	24-60591R53	8 turns
L2664	24-60591B77	4 turns
		transistor: (see note)
Q1	48-13827A07	NPN; type MMBR941
Q2	48-13824A17	PNP; type MMBT3906
Q51, 52	48-13827A07	NPN; type MMBR941
Q53, 54	48-80947V01	digital NPN; type DTC144W
Q271	48-13827A07	NPN; type MMBR941
Q281	48-13827A07	NPN; type MMBR941
Q401	48-80214G02	NPN; type MMBT3904
Q402	48-80947V01	digital NPN; type DTC144W
Q412	48-13824A17	PNP; type MMBT3906
Q413	48-80214G02	NPN; type MMBT3904
Q414	48-80141L03	PNP; type BCW68G
Q451	48-02245J25	PNP; type 2SB1142S
Q452, 453	48-80214G02	NPN; type MMBT3904
Q501	48-80947V01	digital NPN; type DTC144W
Q551	48-80947V01	digital NPN; type DTC144W
Q552 thru 554	48-80494U01	digital PNP; type DTA144W
Q555	48-80947V01	digital NPN; type DTC144W
Q651	48-80947V01	digital NPN; type DTC144W
Q901	48-80947V01	digital NPN; type DTC144W
Q902	48-80141L03	PNP; type BCW68G
Q903 thru 906	48-80947V01	digital NPN; type DTC144W
Q908 thru 911	48-80947V01	digital NPN; type DTC144W
Q2610	48-02245J24	NPN; type BFG35
Q2620	48-80225C09	NPN; type MRF630
Q2630	48-80225C19	NPN; type MRF654
Q2640	48-80225C24	NPN; type MRF650
		resistor, fixed: +/-5%; 1/16 W:
		unless otherwise stated
R3	06-62057A59	2.7k
R4	06-62057A80	20k
R5	06-62057A73	10k
R6	06-62057A13	33
R7	06-62057A37	330
R8	06-62057A40	430
R11	06-62057C63	330; 1/10 watt
R51	06-62057A18	51
R52	06-62057A83	27k
R53	06-62057A75	12k
R54	06-62057A45	680
R55	06-62057A25	100
R57	06-62057A99	120k
R58	06-62057A76	13k
R59	06-62057A97	100k
R60	06-62057A81	22k
R63	06-62057A83	27k
R64	06-62057A91	56k
R65	06-62057A61	3.3k
R66	06-62057A47	820
R67	06-62057A56	2k
R68 thru 70	06-62057A73	10k
R71	06-62057A61	3.3k
R201	06-62057A57	2.2k
R202	06-62057A89	47k
R221	06-62057A57	2.2k
R222	06-62057A23	82
R223	06-62057A61	3.3k
R231	06-62057A49	1k
R232	06-62057A57	2.2k
R233	06-62057A82	24k
R242	06-62057B06	220k
R251	06-62057A77	15k
R252	06-62057A52	1.3k
R253	06-62057A33	220
R260	06-62057A33	220
R271	06-62057A75	12k
R272	06-62057A69	6.8k
R273	06-62057A32	200
R274	06-62057A49	1k
R281	06-62057A47	820
R282	06-62057A59	2.7k
R283	06-62057A15	39
R284	06-62057A37	330
R285	06-62057A05	15
R286	06-62057A37	330
R287	---	Not Used
R291	06-62057A84	30k
R292	06-62057A25	100
R293	06-62057A81	22k
R294	06-62057A84	30k
R401	06-62057B28	1.8 meg
R402	06-62057A65	4.7k
R403	06-62057A73	10k
R404	06-62057A49	1k
R405	06-62057C81	1.8k; 1/10 watt
R406	06-62057A65	4.7k
R407	06-62057A89	47k
R408	06-62057A65	4.7k
R409	06-62057A33	220
R411	06-62057A73	10k
R412	06-62057A41	470
R413 thru 415	06-62057A73	10k
R416	06-62057A49	1k
R421, 422	06-62057A97	100k
R423 thru 425	06-62057A73	10k
R426	06-62057A01	10
R427	06-62057A73	10k
R428	06-62057A97	100k
R432	06-62057A65	4.7k
R434	06-62057A61	3.3k
R435	06-62057A45	680
R436	06-62057C67	470; 1/10 watt
R439	06-62057A73	10k
R440	06-62057A90	51k
R441, 442	06-62057A01	10
R443	06-62057B47	0
R451	06-62057A45	680
R452	06-80195M37	330; 1/2 watt
R453	06-62057A45	680
R454	06-62057A49	1k
R455 thru 458	06-62057A73	10k
R459	06-62057A77	15k
R460	06-62057A65	4.7k
R461	06-62057A73	10k
R462	06-05621T02	thermistor 50k @ 25 degrees C
R463	06-62057A45	680
R464	06-62057A33	220
R465	06-62057A25	100
R501	06-62057A37	330
R502	06-62057A97	100k
R551	06-62057A84	30k
R552	06-62057A65	4.7k
R553	06-62057A71	8.2k
R554	18-04405J02	variable 2k with switch
R556	06-62057A73	10k
R557	06-62057A01	10
R558	06-62057A73	10k
R559	06-62057A17	47
R560	06-62057A97	100k
R561, 562	06-62057A89	47k
R564	06-62057A77	15k
R566	06-62057A71	8.2k
R567, 568	06-62057A89	47k
R569	06-62057A43	560
R570	06-62057A56	2k
R572	06-62057B07	240k
R573	06-62057A73	10k
R574	06-62057B08	270k
R575	06-62057A95	82k
R576	06-62057A92	62k
R577, 578	06-62057A84	30k
R579, 580	06-62057A69	6.8k
R581	06-62057A85	33k
R582, 583	06-62057A90	51k
R584	06-62057A85	33k
R585	06-62057A97	100k
R586	06-62057A61	3.3k
R587	06-62057B14	470k
R588	06-62057A95	82k
R589	06-62057A37	330
R590	06-62057A77	15k
R651	06-62057B04	180k
R652	06-62057B14	470k
R653	06-62057A01	10
R654	06-62057A82	24k
R655	06-62057A84	30k
R656	06-62057A73	10k
R657	06-62057A97	100k
R658	06-62057A20	62
R659	06-62057A40	430
R660	06-62057A73	10k
R665	06-62057A40	430
R666	06-62057A20	62
R667, 668	06-62057A97	100k
R669	06-62057A91	56k
R670	06-62057B09	300k
R671, 672	06-62057A91	56k
R701	06-62057A97	100k
R702	06-62057B06	220k
R703	06-62057B03	160k
R704, 705	06-62057A77	15k
R706, 707	06-62057A99	120k
R708	06-62057A91	56k
R901	06-62057A53	1.5k
R902	06-62057C85	2.7k; 1/10 watt
R903	06-62057A73	10k
R904	06-62057A89	47k
R905	06-62057A65	4.7k
R906	06-62057A89	47k
R907	06-62057A65	4.7k
R908	06-62057A89	47k
R909	06-62057A65	4.7k
R912	06-62057A89	47k
R913	06-62057A65	4.7k
R914	06-62057A89	47k
R915	06-62057A65	4.7k
R2610	06-62057C57	180; 1/10 watt
R2611	06-62057C59	220; 1/10 watt
R2612	06-62057C53	120 ;1/10 watt
R2613, 614	06-62057C36	24; 1/10 watt
R2615, 2616	---	Not Used
R2620	---	Not Used
R2640	06-62057C27	10; 1/10 watt
R2651	06-80194M23	82; 1 watt
R2660		Not Used
R2675	06-62057C27	10; 1/10 watt
R2681, 2682	06-80195M25	100; 1/2 watt
R2683	06-62057A73	10k
R2684	06-62057A65	4.7k
R2685	06-62057A67	5.6k
R2686	06-62057A65	4.7k
		integrated circuit: (see note)
U1	51-80505D05	double-balanced mixer
U2	48-09939C04	dual transistor switch UMC3TL
U51	51-80605E02	receiver system
U52	51-05663U35	quad analog switch 4066B
U53	51-05663U35	quad analog switch 4066B
U201*		synthesizer
U251	51-05414S84	VCO/buffer
U401*		microcomputer MC68HC11KA4
U402	51-80604E01	audio filter
U404	51-80633C01	5 V regulator TK11950
U405	51-05469E65	5 V regulator LP2951C
U406	51-13816D03	8 V regulator MC7808BT
U451	51-80932W01	dual op-amp LM2904 SOIC
U501	51-80147R01	audio power amp TDA1519C
U551	51-02198J28	quad op-amp LM2902D SOIC
U552	51-62852A09	single opamp LMC7101
U553	51-84704M60	triple 2-channel switch 4053B
U554	51-05663U35	quad analog switch 4066B
U555	51-13811A35	compander MC33111
U651	51-05461G61	NAND gate TC7S00F
U652	48-09939C04	dual transistor switch UMC3TL
		voltage regulator: (see note)
VR401	48-80140L06	zener diode 5.1 V SOT
VR402	48-80948V01	zener diode 27 V SOT
VR409	48-80948V01	zener diode 27 V SOT
VR410	48-80140L15	zener diode 10 V SOT
VR411, 412	48-80948V01	zener diode 27 V SOT
VR451	48-80140L15	zener diode 10 V SOT
VR551 thru 553	48-80140L15	zener diode 10 V SOT
VR901 thru 904	48-80948V01	zener diode 27 V SOT
VR906 thru 909	48-80948V01	zener diode 27 V SOT
		crystal: (see note)
Y51	91-80112R13	filter 44.85 MHz
		(includes Y51A and Y51B)
Y52	48-80606B07	44.395 MHz
Y201*		16.8 MHz
Y401	48-80113R01	7.9488 MHz
		non-referenced items
	14-05160A02	crystal insulator (for Y201)
	26-04398J01	VCO/synthesizer shield (4 used)
	26-04399J01	receiver mixer bottom shield
	26-04400J01	receiver front end top shield
	26-04419J01	PA shield frame
	26-04420J01	PA shield cover
	26-80481U01	TX buffer top shield
	42-80281L01	ground clip (2 used for Q2640)

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

Designators marked with an (*) denote parts which are not field serviceable. Recalibration of the radio using specialized factory equipment is mandatory when these components are replaced in order to guarantee the specified frequency stability of the radio at temperature extremes.

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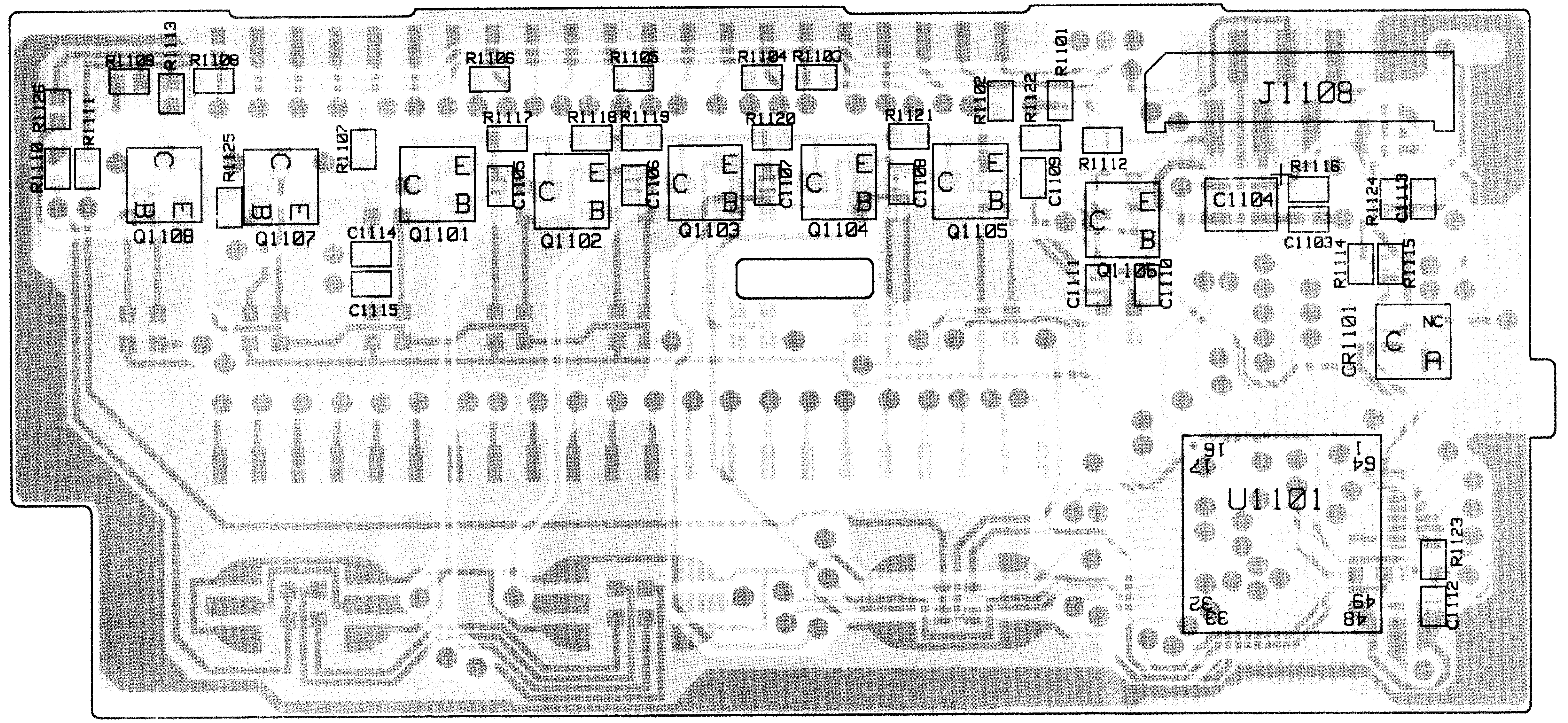
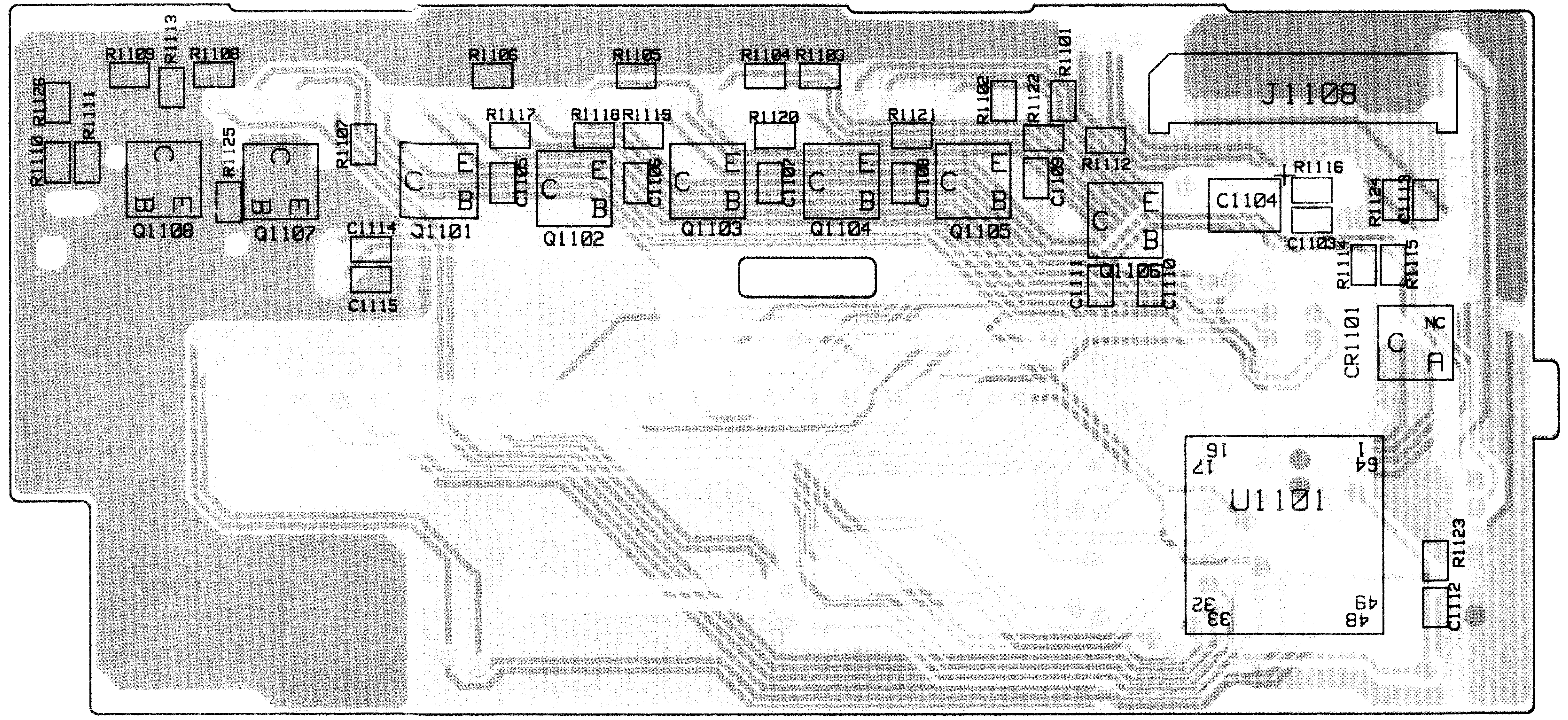
Parts List for
UHF Main Boards, 450-474 MHz, 12.5 & 25 kHz, 10-25 W
(Part of HUE3871A & HUE3580A Radios)



COMPONENT SIDE
84-80440U02 ISS P10

COMPONENT SIDE (GRAY)	RCB-97113-O
SOLDER SIDE (PINK)	RCB-97116-O
OVERLAY -----	RCB-96117-O

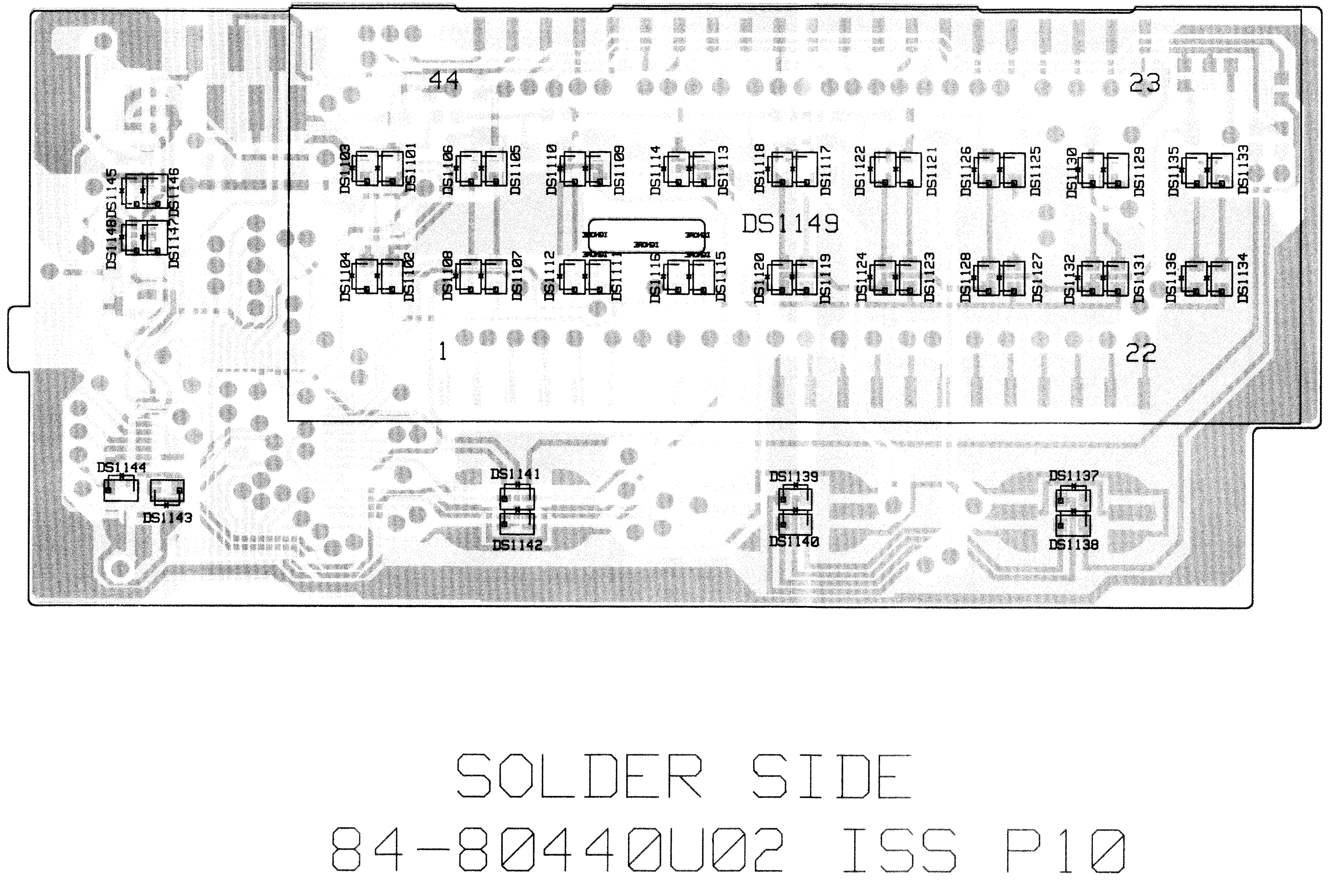
COMPONENT SIDE VIEW



COMPONENT SIDE
84-80440U02 ISS P10

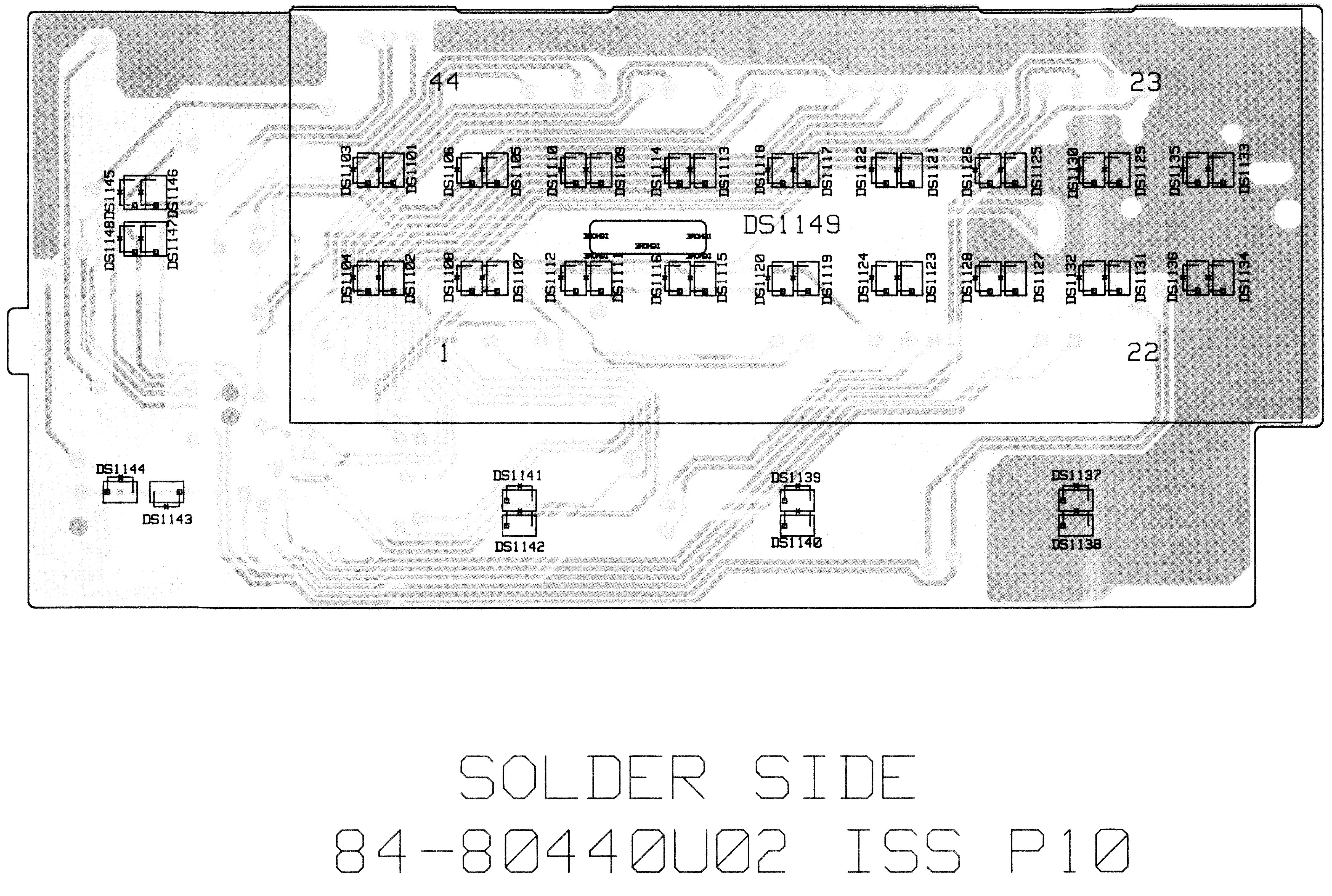
COMPONENT SIDE INNER LAYER (GRAY)	RCB-97114-O
SOLDER SIDE INNER LAYER (PINK)	RCB-97115-O
OVERLAY -----	RCB-97117-O

COMPONENT SIDE VIEW



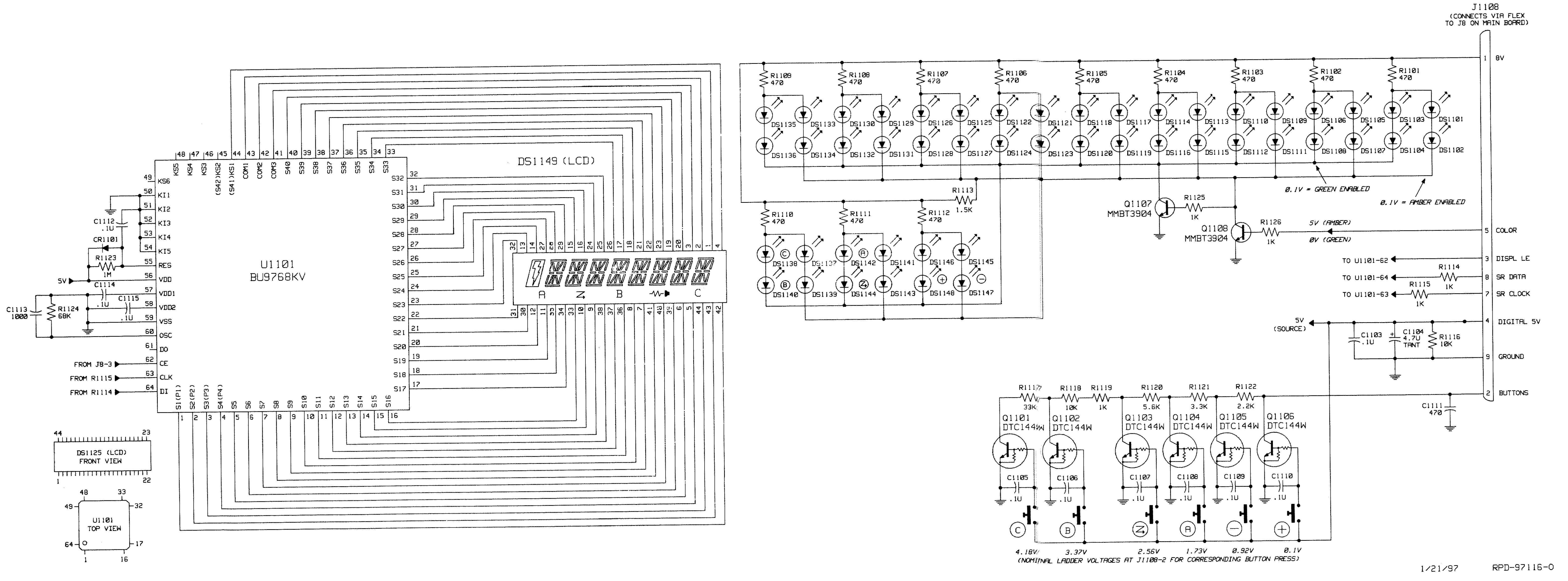
COMPONENT SIDE (GRAY)	RCB-97113-O (REV)
SOLDER SIDE (PINK)	RCB-97116-O (REV)
OVERLAY -----	RCB-97118-O

SOLDER SIDE VIEW



COMPONENT SIDE INNER LAYER (GRAY)	RCB-97114-O (REV)
SOLDER SIDE INNER LAYER (PINK)	RCB-97115-O (REV)
OVERLAY -----	RCB-97118-O

SOLDER SIDE VIEW



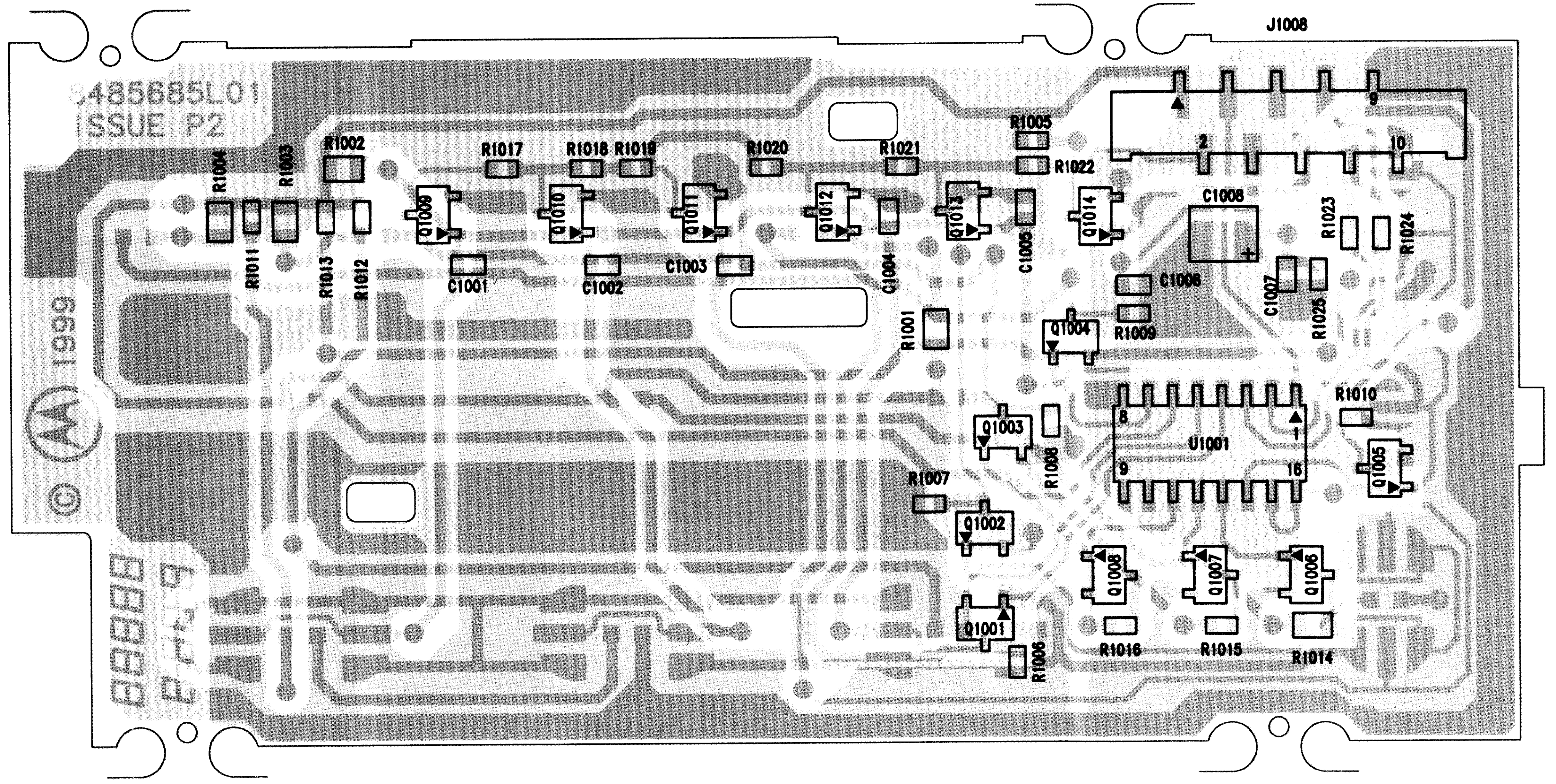
Parts List

M1225 Radio 8-Character Display Board PL-971003-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF +/-5%; 50 V: unless otherwise stated
C1103	21-13743E20	0.1 uF, 10%; 16 V
C1104	23-11049A13	tantalum 4.7 uF, 10%; 10 V
C1105 thru 1110	21-13743E20	0.1 uF, 10%; 16 V
C1111	21-13741F17	470 pF
C1112	21-13743E20	0.1 uF, 10%; 16 V
C1113	21-13741F25	1000 pF
C1114, 1115	21-13743E20	0.1 uF, 10%; 16 V
		diode: (see note)
CR1101	48-80939T01	Schottky SOT
		displays and indicators:
DS1101, 1102	48-80479U02	diode LED amber
DS1103, 1104	48-80479U01	diode LED green
DS1105	48-80479U02	diode LED amber
DS1106	48-80479U01	diode LED green
DS1107	48-80479U02	diode LED amber
DS1108	48-80479U01	diode LED green
DS1109	48-80479U02	diode LED amber
DS1110	48-80479U01	diode LED green
DS1111	48-80479U02	diode LED amber
DS1112	48-80479U01	diode LED green
DS1113	48-80479U02	diode LED amber
DS1114	48-80479U01	diode LED green
DS1115	48-80479U02	diode LED amber
DS1116	48-80479U01	diode LED green
DS1117	48-80479U02	diode LED amber
DS1118	48-80479U01	diode LED green
DS1119	48-80479U02	diode LED amber
DS1120	48-80479U01	diode LED green
DS1121	48-80479U02	diode LED amber
DS1122	48-80479U01	diode LED green
DS1123	48-80479U02	diode LED amber
DS1124	48-80479U01	diode LED green
DS1125	48-80479U02	diode LED amber
DS1126	48-80479U01	diode LED green
DS1127	48-80479U02	diode LED amber
DS1128	48-80479U01	diode LED green
DS1129	48-80479U02	diode LED amber
DS1130	48-80479U01	diode LED green
DS1131	48-80479U02	diode LED amber
DS1132	48-80479U01	diode LED green
DS1133, 1134	48-80479U02	diode LED amber
DS1135, 1136	48-80479U01	diode LED green
DS1137	48-80479U02	diode LED amber
DS1138	48-80479U01	diode LED green
DS1139	48-80479U02	diode LED amber
DS1140	48-80479U01	diode LED green
DS1141	48-80479U02	diode LED amber
DS1142	48-80479U01	diode LED green
DS1143	48-80479U02	diode LED amber
DS1144	48-80479U01	diode LED green
DS1145	48-80479U02	diode LED amber
DS1146	48-80479U01	diode LED green
DS1147	48-80479U02	diode LED amber
DS1148	48-80479U01	diode LED green
DS1149	72-80451U02	display, LCD
		connector, receptacle:
J1108	09-04422J01	10 pin, main board
		transistor: (see note)
Q1101 thru 1106	48-80947V01	digital NPN; type DTC144W
Q1107, 1108	48-80214G02	NPN; type MMBT3904
		resistor, fixed: +/-5%; 1/16 W:
R1101 thru 1112	06-62057A41	470
R1113	06-62057A53	1.5k
R1114, 1115	06-62057A49	1k
R1116	06-62057A73	10k
R1117	06-62057A85	33k
R1118	06-62057A73	10k
R1119	06-62057A49	1k
R1120	06-62057A67	5.6k
R1121	06-62057A61	3.3k
R1122	06-62057A57	2.2k
R1123	06-62057B22	1 meg
R1124	06-62057A93	68k
R1125, 1126	06-62057A49	1k
		integrated circuit: (see note)
U1101	51-80449U01	LCD driver BU9768KV

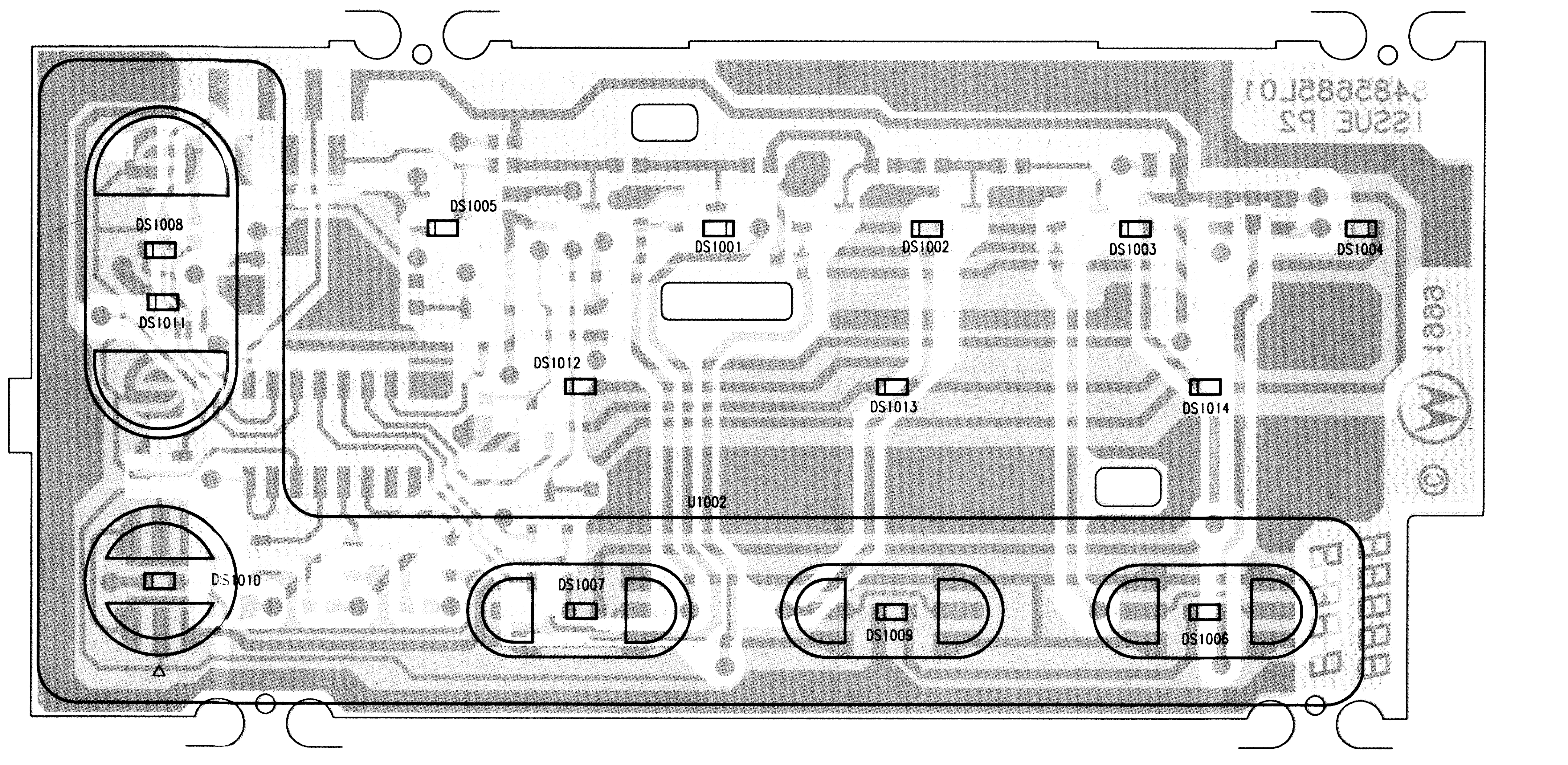
note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

Schematic Diagram, and Parts List for HLN9644A 8-Character Display Board, 20-Frequency



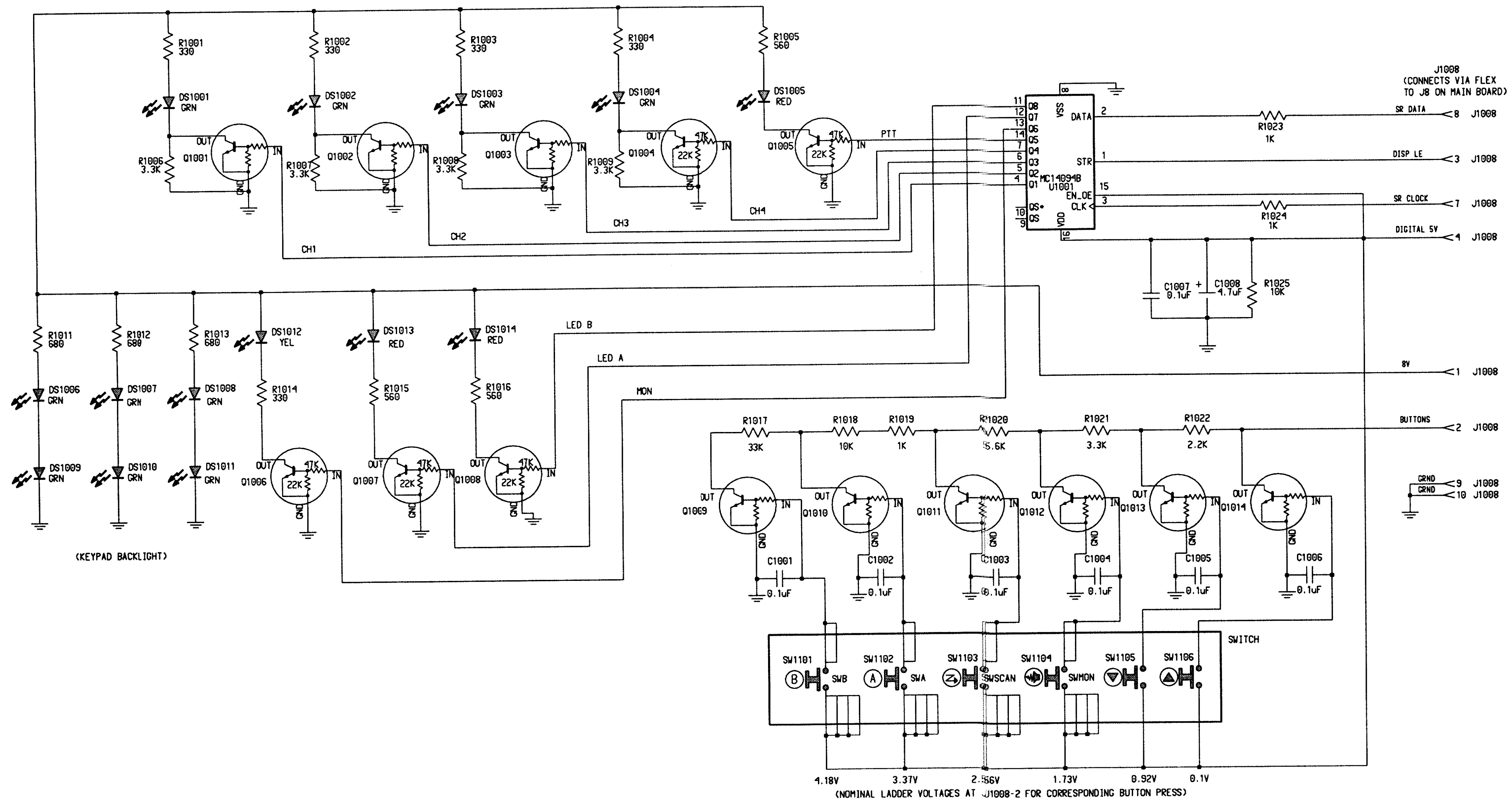
COMPONENT SIDE (GRAY)	RCB-98132-O
SOLDER SIDE (PINK)	RCB-98133-O
OVERLAY -----	RCB-98134-O

COMPONENT SIDE VIEW



COMPONENT SIDE (GRAY)	RCB-98132-O (REV)
SOLDER SIDE (PINK)	RCB-98133-O (REV)
OVERLAY -----	RCB-98135-O

SOLDER SIDE VIEW



RPD-99111-0

Parts List

M1225 Radio 4-Channel Display Board — PL-991006-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF +/-5%; 50 V: unless otherwise stated
C1001 thru 1007	21-13743E20	0.1 uF, 10%; 16 V
		displays and indicators:
DS1001 thru 1004	48-80479U01	diode LED green
DS1005	48-80479U03	diode LED red
DS1006 thru 1011	48-80479U01	diode LED green
DS1012	48-80479U05	diode LED yellow
DS1013, 1014	48-80479U03	diode LED red
		connector, receptacle:
J1008	09-04422J01	10 pin, main board
		transistor: (see note)
Q1001 thru 11014	48-80947V01	digital NPN; type DTC144W
		resistor, fixed: +/-5%; 1/16 W:
R1001 thru 1004	06-60076A37	330
R1005	06-62057A43	560
R1006 thru 1009	06-62057A61	3.3k
R1010	---	Not Used
R1011 thru 1013	06-62057A45	680
R1014	06-60076A37	330
R11015, 1016	06-62057A43	560
R1017	06-62057A85	33k
R1018	06-62057A73	10k
R1019	06-62057A49	1k
R1020	06-62057A67	5.6k
R1021	06-62057A61	3.3k
R1022	06-62057A57	2.2k
R1023, 1024	06-62057A49	1k
R1025	06-62057A73	10k
		integrated circuit: (see note)
U1001	51-13806A35	MC14094B
U1002	75-80450U01	Switch, keypad 28-pin

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

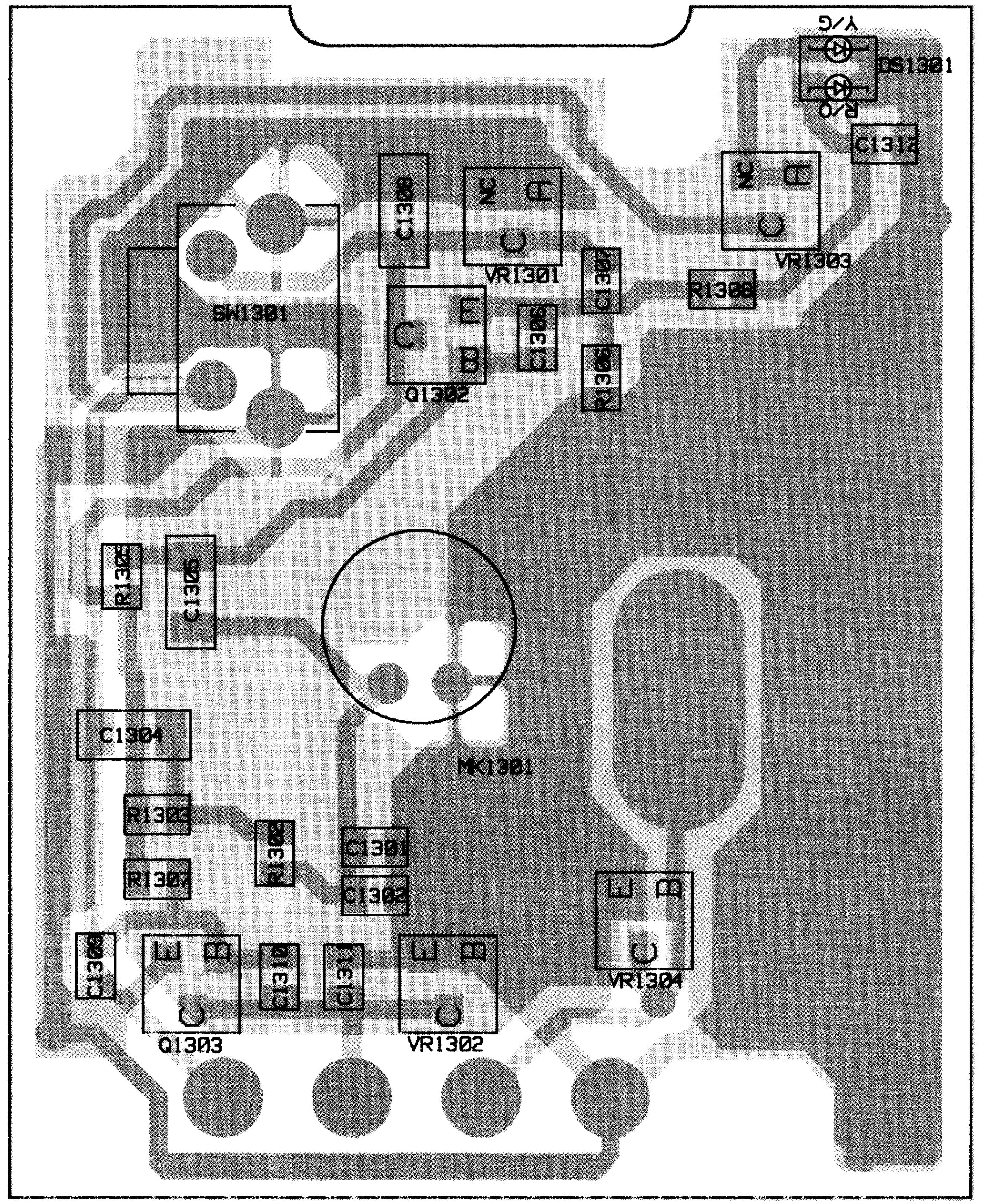
Schematic Diagram, and Parts List for HLN9887A Display Board, 4-Frequency

Parts List

01-80446E01 Microphone Board with Cord PL-971005-A

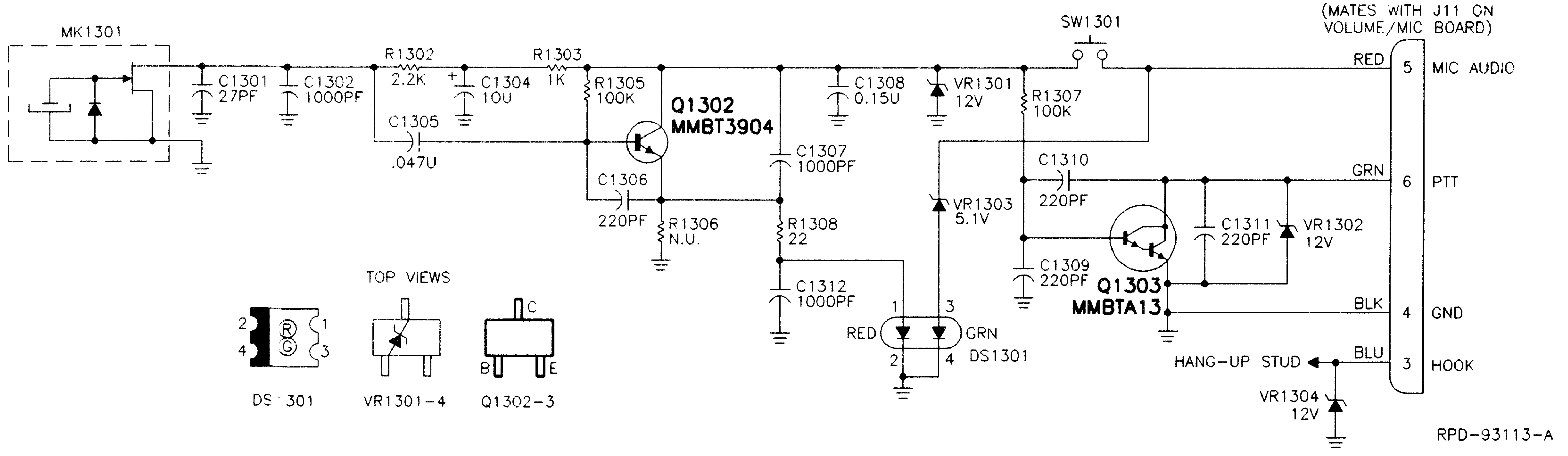
REFERENCE NUMBER	MOTOROLA PART NO.	DESCRIPTION
		capacitor, chip, uF +/-5%, 50 V; unless otherwise stated
C1301	21-13740A39	27 pF
C1302	21-13740A79	1000 pF
C1304	23-11049A59	tantalum 10 uF, ±10%; 6 V
C1305	21-13741A61	.047 uF
C1306	21-13740A59	150 pF
C1307	21-13740A79	1000 pF
C1308	21-11032B14	0.15 uF
C1309, 1310	21-13740A59	150 pF
C1311	21-13740A59	150 pF
C1312	21-13740A79	1000 pF
		display:
DS1301	48-05729G49	dual LED red/grn
		microphone:
MK1301	50-80258E04	cartridge electret
		transistor: see note
Q1302	48-80214G02	NPN; type MMBT3904
Q1303	48-05128M19	NPN Darlington; type MMBTA13
		resistor, chip: uF +/-5%, 1/10 W: unless otherwise stated
R1302	06-60076A57	2.2k
R1303	06-60076A49	1k
R1305	06-60076B01	100k
R1306	---	Not Used
R1307	06-60076B01	100k
R1308	06-60076A09	22
		switch:
SW1301	40-80164S01	momentary pushbutton
		voltage regulator: see note
VR1301, 1302	48-80140L17	Zener diode SOT 12 V MMBZ5242L
VR1303	48-80140L06	Zener diode SOT 5.1 V MMBZ5231L
VR1304	48-80140L17	Zener diode SOT 12 V MMBZ5242L
		non-referenced items
	30-80978Z03	coiled cord

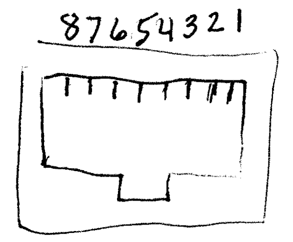
note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.



COMPONENT SIDE (GRAY) RCB-95101-O
SOLDER SIDE (PINK) RCB-95102-O
OVERLAY ----- RCB-95103-O

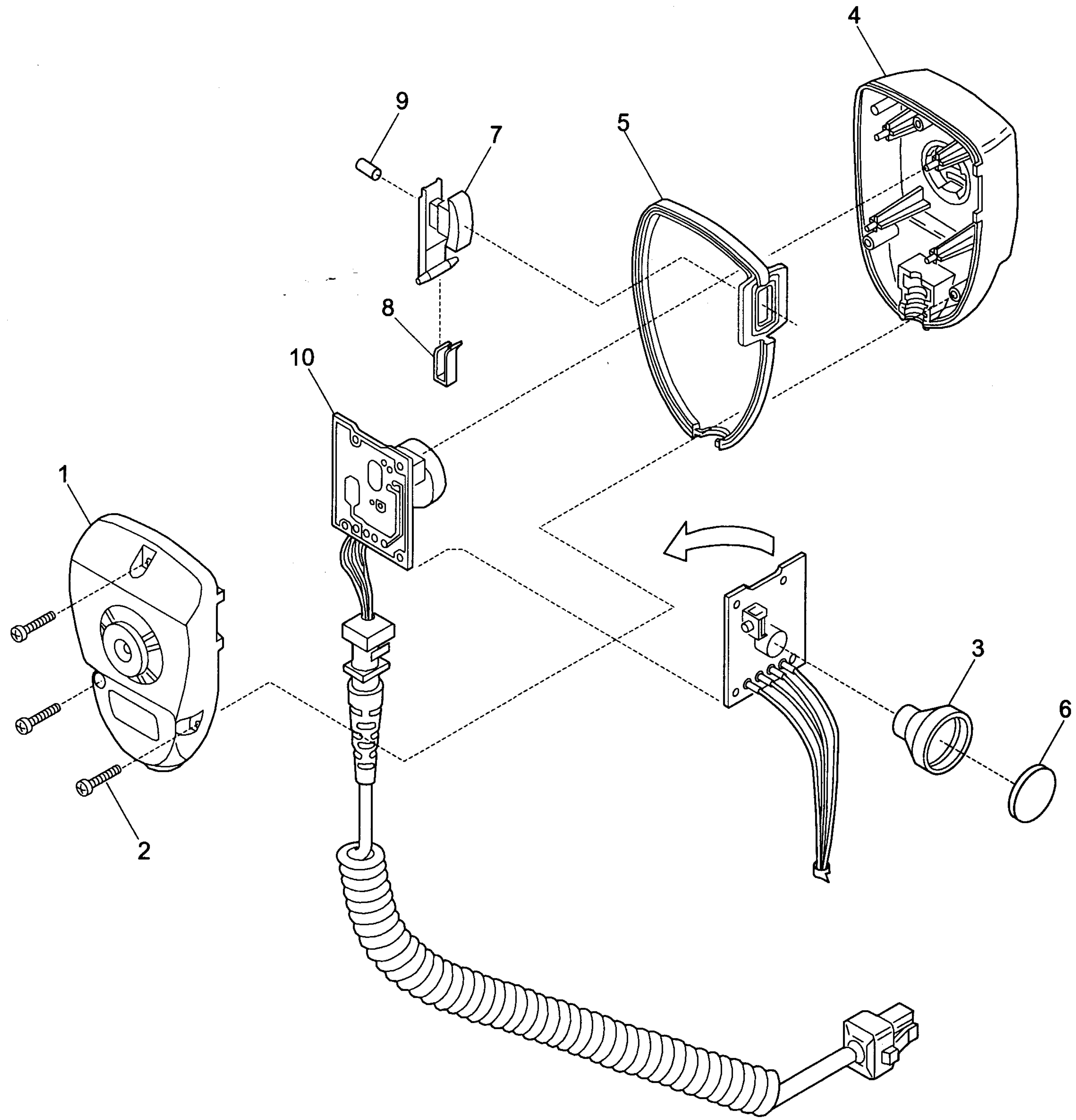
COMPONENT SIDE VIEW





LOOKING INTO JACK HOLE

Circuit Board Details, Schematic Diagram, and Parts List for HMN3001/3008A Compact Microphone



RPD-97106-0

Parts List

HMN3001A / 3008A Compact Microphone w/LED Indicator PL-971006-A

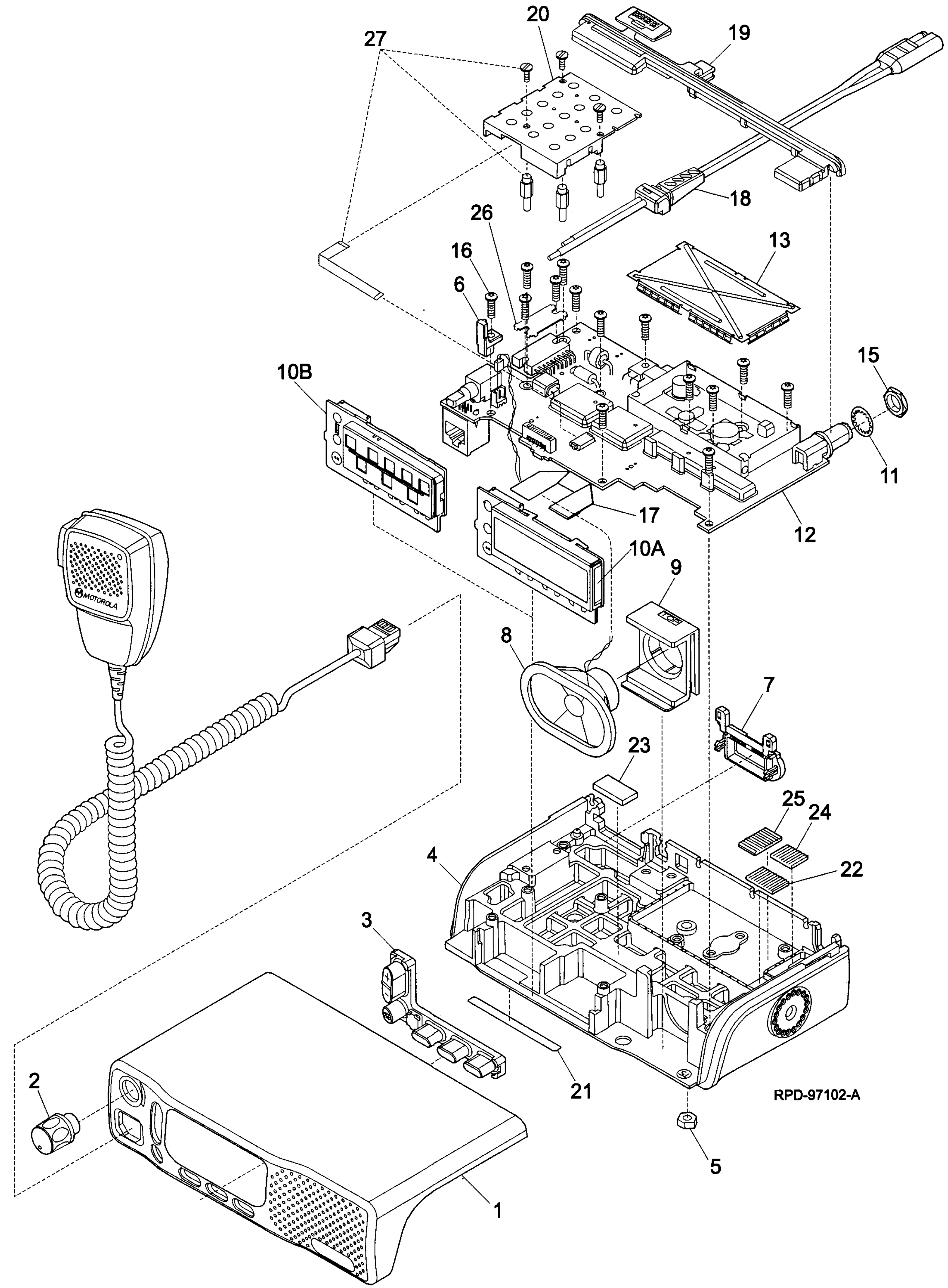
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	0180669D01	Assembly, HOUSING, rear
2	0300139959	SCREW, 5-20 x 5/8; 3 used
3	0580149R01	GROMMET, microphone
4	1580443E03	* HOUSING, front
5	3280565B01	GASKET, microphone
6	3580132R01	BAFFLE, flet
7	3880654D01	BUTTON, PTT
8	4180658D01	SPRING, PTT
9	7580983Z01	RUBBER SPACER, switch
10	---	PC board

Note: The front cover of the HMN3008A microphone has holes and a "Motorola" name. The HMN3174 mike is identical, except that the front cover has horizontal slots and a "Radius" nameplate.

Parts List

M1225 Radio Exploded View, Mechanical PL-971004-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	0180427U02	ASSY, HOUSING, 20-channel
	0180427U03	ASSY, HOUSING, 4-channel
2	3604414J01	KNOB, volume control
3	7580450U01	KEYPAD, 20-channel
	7580450U03	KEYPAD, 4-channel
4	2680448U01	HEATSINK
5	0280478U01	NUT, Mini-U
6	4380587U01	FLANGE, right angle, PC support
7	1504501J01	SHROUD, spacer, snap-on
8	5080442U01	SPEAKER, w/wire assembly
9	3204411J01	GROMMET, speaker retaining
10A	HLN9644	ASSY, front panel display, 20-channel
10B	HLN9887	ASSY, front panel display, 4-channel
11	400007698	WASHER, lock, Mini-U
12	---	Main Board
13	2604420J01	SHIELD, PA frame cover
14	0980476U01	CONNECTOR, antenna, Mini-U
15	0280477U01	NUT, Mini-U
16	0310943J11	SCREW, 3mm x 10; 14 used
17	2804431J01	CABLE, folded; 10 position
18	3080486U01	CABLE, power w/strain relief
19	3280484U01	GASKET, rear
20	---	Option Board
21	5404605J01	LABEL, warning
22	3204416J01	GASKET, thermal conductive pad
23	7504682J01	PAD, pullout VCO
24	3204416J01	GASKET, thermal conductive pad (Modified for UHF only)
25	3204416J01	GASKET, thermal conductive pad (Modified for VHF only)
26	0780443U01	SPANNER
27	HLN9345	Option Board Installation kit
	non-referenced Items	
	13-80482U01	ESCUTCHEON



M1225 Radio Exploded Mechanical View and Parts List